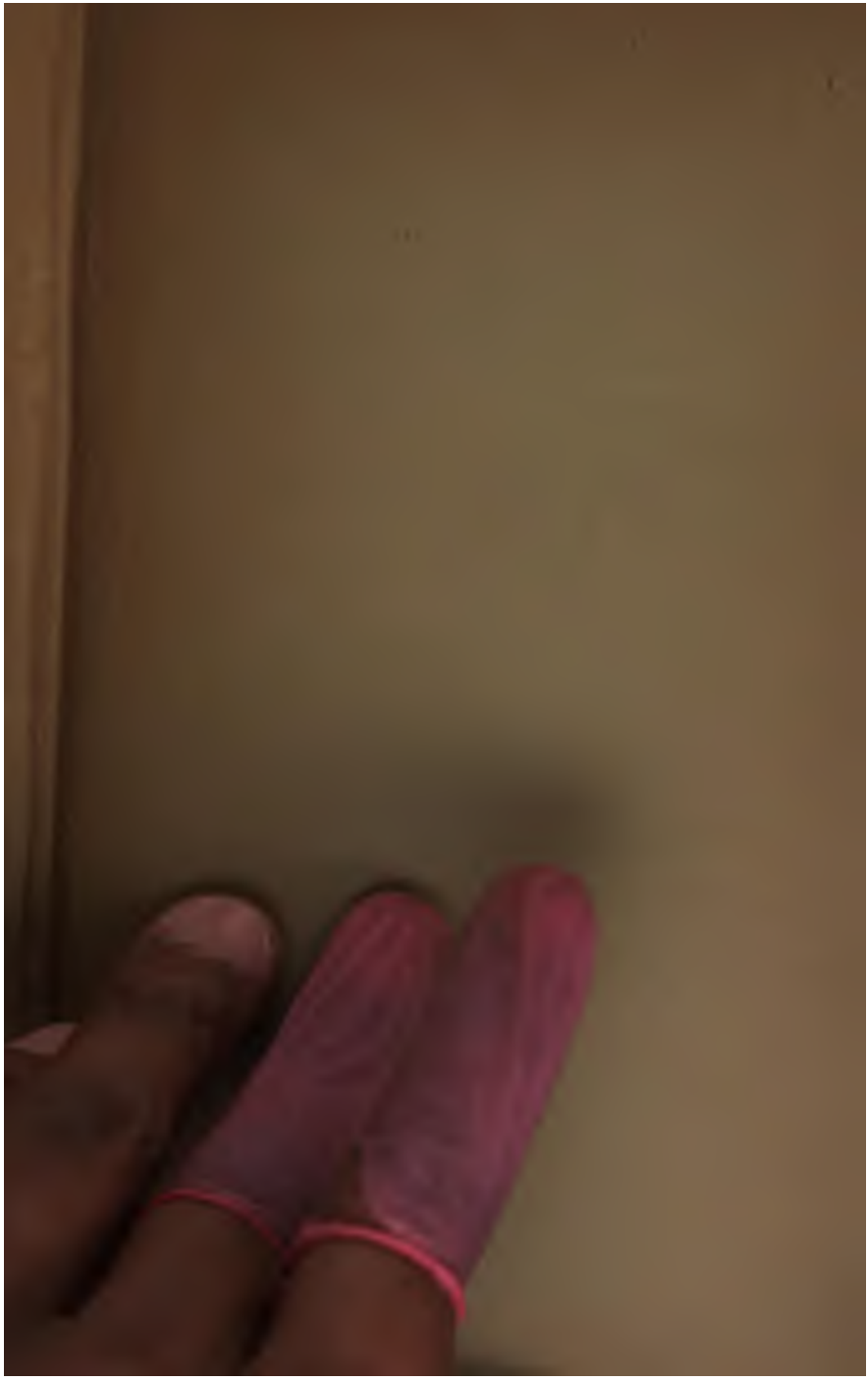
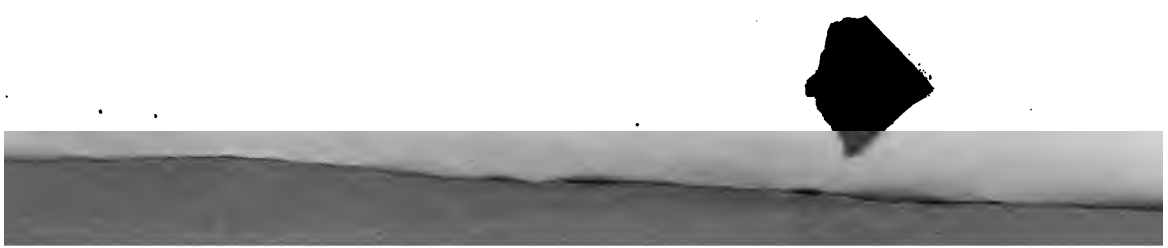




NORMAL FUNDUS.
(Average Color.)

A

MANUAL

OF

CLINICAL OPHTHALMOLOGY

BY

HOWARD F. HANSELL, M.D.,

LECTURER ON OPHTHALMOLOGY IN THE JEFFERSON MEDICAL COLLEGE; CHIEF CLINICAL ASSISTANT IN EYE DEPARTMENT, JEFFERSON MEDICAL COLLEGE HOSPITAL; MEMBER OF AMERICAN OPHTHALMOLOGICAL SOCIETY; FELLOW OF THE COLLEGE OF PHYSICIANS, PHILADELPHIA, ETC.,

AND

JAMES H. BELL, M.D.,

LATELY DEMONSTRATOR OF ANATOMY IN JEFFERSON MEDICAL COLLEGE; MEMBER OF OPHTHALMOLOGICAL STAFF, JEFFERSON MEDICAL COLLEGE HOSPITAL; OPHTHALMIC SURGEON TO SOUTHWESTERN HOSPITAL AND DISPENSARY, ETC.

WITH 120 ILLUSTRATIONS.

PHILADELPHIA:
P. BLAKISTON, SON & CO.,
1012 WALNUT STREET.
1892.

PRESS OF WM. F. FELL & CO.
1220-24 SANSOM ST.
PHILADELPHIA.

TO

WILLIAM THOMSON, M. D.,

PROFESSOR OF OPHTHALMOLOGY, JEFFERSON MEDICAL COLLEGE,

AS A DISTINGUISHED REPRESENTATIVE OF THE SCIENCE,

AND

IN RECOGNITION OF HIS FRIENDSHIP,

THIS VOLUME IS INSCRIBED

WITH THE SINCERE RESPECT AND ESTEEM OF

THE AUTHORS.

PREFACE.

It has been our purpose in the following pages to place before the undergraduate and general practitioner of medicine, a brief review of the anatomy, physiology, refraction, and common diseases of the eye. No attempt has been made to treat the subjects exhaustively. Simplicity and brevity of statement have not been sacrificed to the mere attractiveness of literary finish. We have, in a word, endeavored in good faith, to make the volume conform to the purpose for which it was written, by giving it the character, directness, and practicability of clinical teaching and practice.

We have been equally and jointly engaged in the composition and arrangement of each and every chapter, and for all portions of the book we are, therefore, equally and jointly responsible.

TABLE OF CONTENTS.

PART IV.

PAGE

The Ocular Muscles.

PART V.

Diseases of the Conjunctiva.

PART VI.

Diseases of the Lids.

Diseases of the Lacrymal Apparatus.

PART VII.

Diseases of the Cornea.

Diseases of the Sclera.

PART VIII.

PART IX.

PART X.

PART XI.

PART XII.

PART XIII.

PAGE

Diseases of the Optic Nerve.

PART XIV.

Diseases of the Orbital Cavity.

PART XV.

Operations.

LIST OF ILLUSTRATIONS.*

* None of the illustrations are original; they have been taken from the works of Meyer, Nettleship, Landois and Stirling, Littell, Harlan, and Jaeger. E. A. Yarnall & Co. have furnished the cuts for the instruments, and J. L. Borsch & Co. for lenses and for an astigmatic chart.

ERRATUM.

Page 77, line 9. *Hydrobromate* should read *Hydrochlorate.*

A MANUAL

OF

CLINICAL OPHTHALMOLOGY.

PART I.

GENERAL CONSIDERATIONS—STRUCTURAL AND PHYSIOLOGICAL.

The human eyeball is spheroidal in shape; 24 mm. in its antero-posterior, 23 mm. in its transverse, and 23 mm. in its vertical axis. Three tunics are commonly described, namely, an inner percipient coat, the retina, a middle vascular coat, the choroid, and an outer and protecting coat, the sclera, with its transparent continuation in front, the cornea.

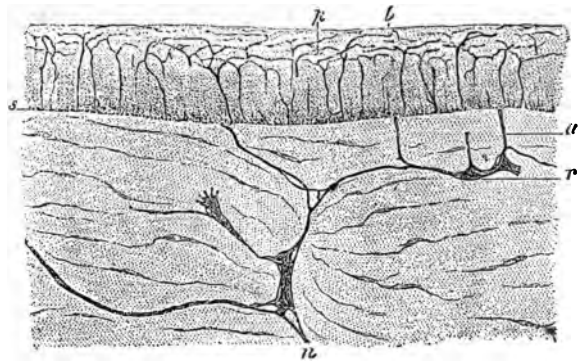
The *sclera* is a bluish-white, opaque, dense, resisting membrane, composed of closely interlacing connective tissue fibres with a sparse intermingling of fine elastic tissue. Among the fibres are numerous lymph channels communicating with the lymph system of the cornea, the underlying peri-choroid, and with the overlying capsule of Tenon. A few small blood-vessels and nerves are distributed throughout its substance. Slightly below and four mm. to the nasal side of the posterior extremity of the horizontal axis of the

ball is an incomplete opening, 1½ mm. in diameter, *the sclerotic foramen*, over which is stretched a white fibrous veil, the *lamina cribrosa*, pierced by the optic nerve, central artery and vein of the retina. At the margin of this foramen the sclera is one mm. thick, being reinforced by a deflection of the outer sheath of the optic nerve, and gradually thins off anteriorly, to be again reinforced six to eight mm. back of the limbus cornea, *corneo-scleral margin*, by the expanding tendons of the recti muscles. It is marked just at its corneal border by a slight depression, the *sulcus sclera*. The sclera is pierced ten to twelve mm. from the foramen sclera by the posterior ciliary vessels and nerves; again midway between the optic nerve entrance and cornea, by four or five large veins, venæ vorticosæ, which empty into the ophthalmic vein. It is again perforated two mm. from the limbus cornea by the anterior ciliary vessels, four or five in number.

The *cornea* is the anterior, smaller and transparent portion of the external tunic, measuring eleven mm. vertically, twelve mm. horizontally, and one mm. in thickness at its apex. The layers may be multiplied indefinitely by resorting to useless and confusing subdivision; three are here given. The anterior layer consists of columnar epithelium continuous with the epithelium of the conjunctiva, and a homogeneous elastic, basement membrane (Bowman's). The second or middle layer composes the tissue proper of the cornea, and is formed by sixty or more laminæ of fibrous tissue, containing, in great number, irregularly placed lymph spaces, in which lie the corneal cells, connected with each other in all directions by canaliculi. The posterior layer consists of a homogeneous basement membrane (Descemet's), on which is a single layer of hexagonal cells continuous with that on the anterior surface of the iris.

In health the cornea is devoid of blood-vessels, except at its periphery, and contains under Bowman's membrane a few terminal branches of the ciliary nerves. There is anatomically no distinct line of union between the sclera and cornea, but the former slightly overlaps the latter on its anterior aspect, and beneath this shelving border of sclera, in clear cornea, lies the *canal of Schlemm*, which is con-

FIG. 1.



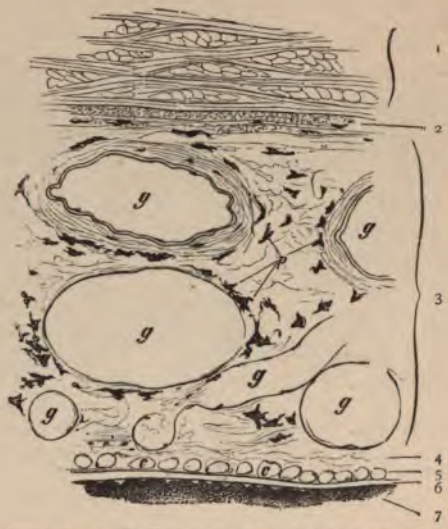
VERTICAL SECTION OF THE CORNEA, STAINED WITH GOLD CHLORIDE.
n. Nerve-fibrils. *a*. Perforating branch. *r*. Nucleus. *p*, *b*. Inter-epithelial termination of fibrils. *s*. Anterior elastic laminæ.

nected with the angle of the anterior chamber by the *spaces of Fontana.*

The *choroid* is the vascular and pigmentary coat, extending posteriorly from the *foramen opticus choroidea*, through which the optic nerve passes, and anteriorly to the ciliary region. Its *outer* surface lines the sclera from which it is separated by a double layer of serous membrane, *supra-choroidal lymph space*, and its inner surface is attached to the basal membrane of the pigment coat of the retina as far forward as the ora serrata. The choroid may be divided into

two layers: an outer, containing relatively larger vessels and more pigment, and an inner, containing capillary vessels and less pigment. The most conspicuous vessels of the external layer are the veins, which, converging, form the *venæ vorticosæ*. The capillary vessels of the inner layer are derived

FIG. 2.



VERTICAL SECTION OF THE CHOROID AND A PART OF THE SCLEROTIC.

1. Sclerotic. 2. Lamina suprachoroidea. 3. Layer of large vessels. 4. Limiting layer. 5. Chorio-capillaris. 6. Hyaline membrane. 7. Pigment epithelium. *g*. Large blood-vessels. *p*. Pigment cells. *c*. Sections of capillaries.

mainly from the short ciliary arteries. The pigment, consisting of hexagonal cells filled with dark-brown granules, is scattered throughout both layers, occupying the meshes between the vessels in quantity and density sufficient to absorb light.

The *ciliary body* comprises the ciliary muscle and pro-

FIG. 3.

ANTERO-POSTERIOR SECTION OF THE CORNEA WITH THE SCLEROTIC.

a. Anterior corneal epithelium. *b*. Bowman's lamina. *c*. Corneal corpuscles. *l*. Corneal lamellæ (the whole thickness lying between *b* and *d* is the substantia propria cornea). *d*. Descemet's membrane. *e*. Its epithelium. *f*. Junction of cornea with the sclerotic. *g*. Limbus conjunctivæ. *h*. Conjunctiva; canal of Schlemm. *k*. Leber's venous plexus (is regarded by Leber as belonging to *i*). *m*, *m*. Meshes in the tissue of the ligamentum iridis pectinatum. *n*. Attachment of the iris. *o*. Longitudinal, *p*, circular (divided transversely) bundles of fibres of the ciliary muscle. *u*. Transverse section of a ciliary artery. *v*. Epithelium of the iris (a continuation of that on the posterior surface of the cornea). *w*. Substance of the iris. *x*. Pigment of the iris. *z*. A ciliary process.

cesses, and the space they occupy, together with the corresponding circular strip of sclera, is the *ciliary region*. The ciliary muscle, attached anteriorly to the *ligamentum pectinatum iridis* and lost posteriorly in the choroid opposite to the ora serrata, consists of radiating and circular bundles of unstriped muscular fibre, containing the arterial circle, the *circulus ciliaris*.

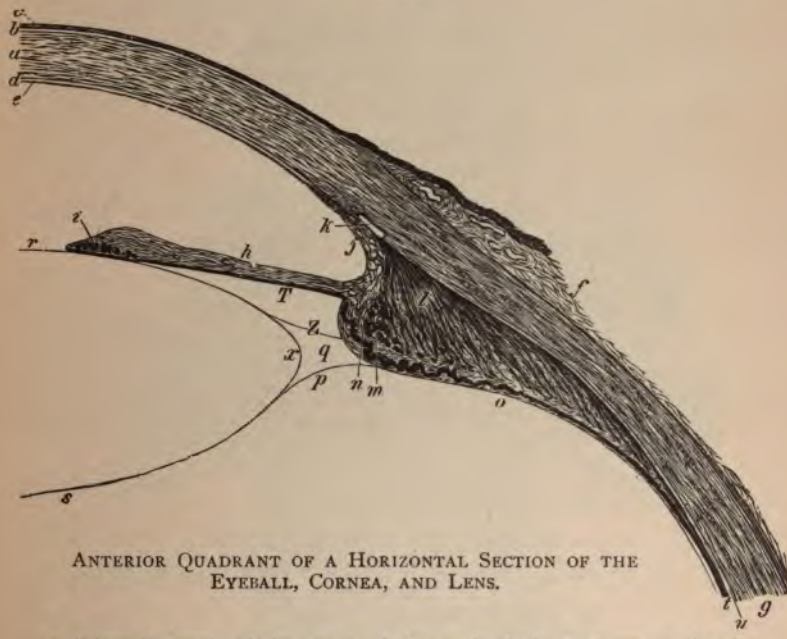
The ciliary processes consist of an anterior prolongation of the pigment stroma and blood-vessels of the choroid, with a reduplication into sixty or seventy folds, resting on the anterior periphery of the vitreous.

The *Zone of Zinn* is the pigmented indentations made by the ciliary processes in the hyaloid membrane.

The *Iris* is a circular framework of elastic and non-striped muscular fibres, lined anteriorly by flat epithelium, continuous with the membrane of Descemet, and posteriorly by the *uvea*, or pigment coat, continued forward from the ciliary processes. It is suspended in the aqueous humor 2½ mm. behind the cornea, and in front of the lens and ciliary processes. By the ciliary ligament (ligamentum pectinatum iridis) its circumference is attached to the limbus corneæ. It is perforated by a nearly circular hole, the pupil, the margin of which, the pupillary border, lies in contact with the anterior capsule of the lens. The *sphincter pupillæ* is a circular band of muscular fibres surrounding the pupil. The *dilator iridis* is, according to late authorities, not a muscle, but a fibro-elastic tissue. The iris has two circles of anastomosing vessels, the larger surrounding the ciliary and the smaller the pupillary border, branches of the anterior and long ciliary. Filaments from the lenticular (ophthalmic) ganglion, containing motor fibres from 3rd, sensitive from 1st division of 5th, and sympathetic filaments from the carotid plexus, furnish its nerve supply.

The *Retina*, or nervous tunic, is composed of three main layers: the inner, fibre and nerve-cell, the middle, granular, and the internal, or layer of rods, cones and pigment. The

FIG. 4.



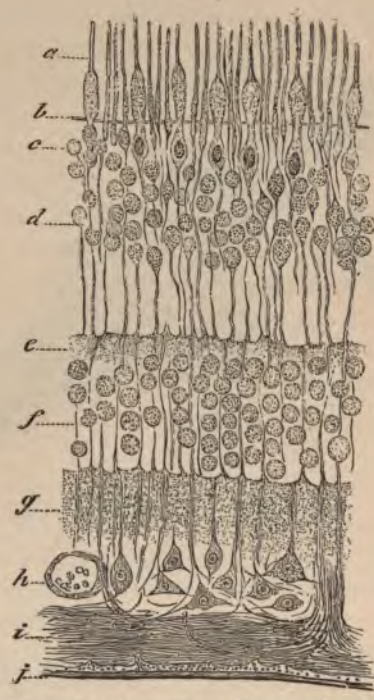
ANTERIOR QUADRANT OF A HORIZONTAL SECTION OF THE EYEBALL, CORNEA, AND LENS.

a. Substantia propria of the cornea. *b*. Bowman's elastic membrane. *c*. Anterior corneal epithelium. *d*. Descemet's membrane. *e*. Its epithelium. *f*. Conjunctiva. *g*. Sclerotic. *h*. Iris. *i*. Sphincter iridis. *j*. Ligamentum pectinatum iridis, with the adjoining vacuolated tissue. *k*. Canal of Schlemm. *l*. Longitudinal, *m*, circular muscular fibres of the ciliary muscle. *n*. Ciliary process. *o*. Ciliary part of the retina. *q*. Canal of Petit, with *Z*, Zonule of Zinn, in front of it, and *p*, the posterior layer of the hyaloid membrane. *r*. Anterior, *v*, posterior part of the capsule of the lens. *t*. Choroid. *u*. Perichoroidal space. *T*. Pigment epithelium of the iris. *x*. Margin of the lens.

first or inner layer consists of the expanded intra-ocular extremity of the optic nerve fibres, stripped of their medullary sheaths, with numerous multipolar cells; the second, of

granular and granulated cells, arranged in four strata, connecting the inner and outer; the third is the sentient layer proper, and is composed of elongated nerve-cells, the rods

FIG. 5.



VERTICAL SECTION OF HUMAN RETINA.

a. Rods and cones. *b*. Ext. and, *j*, int. limit. memb. *c*. Ext. and, *f*, int. nucl. layers. *e*. Ext. and, *g*, int. gran. layers. *h*. Blood-vessels and nerve cells. *i*. Nerve-fibres.

and somewhat shorter cones, inserted into the pigment layer. Each layer is transparent, with the exception of the pigment coat. The retina is about .25 mm. in thickness, covers the under surface of the choroid from the

foramen choroidea to the *ora serrata*, or notched and dentated anterior margin of the retina, allowing the lining membrane of vitreous to come into immediate contact with the choroid for the space of a few mm. behind the ciliary body. The *macula lutea* is a yellowish spot, as seen by the ophthalmoscope, irregular in shape, but usually circular, 0.5 mm. in diameter, and lies slightly to the temporal side of the posterior end of the optic axis. In the centre of the macula

FIG. 6.

SECTION OF THE FOVEA CENTRALIS.

a. Cones. *b* and *g*. Int. and ext. limit. memb. *c*. Ext. and *e*, nuclear layer. *d*. Fibres. *f*. Nerve-cells.

is the *fovea centralis* (Fig. 6), .2 mm. in diameter, characterized by an absence of all the layers of the retina, excepting modified rods and cones. The *central artery and vein* of the retina pass through the *porus opticus*, a comparatively large aperture in the lamina cribrosa, and, dividing, vertically, into large and, horizontally, small vessels, are distributed in the fibre layer of the retina, anastomosing at the ora serrata with the choroidal and, at the optic nerve entrance, with the short ciliary vessels.

The *anterior chamber* is an angular space, bounded in front by the posterior surface of the cornea, at its angle by the ligamentum pectinatum iridis, and behind by the anterior surface of the iris. It secretes and contains the aqueous humor, a feebly saline, transparent fluid.

The smaller *posterior* chamber is bounded in front by the posterior surface of the iris, and behind by the ciliary processes, suspensory ligament of the lens and lens, and contains aqueous humor. The anterior and posterior chambers are in free communication through the pupil.

The *vitreous chamber* is bounded by the retina, ciliary processes and lens, and contains the vitreous humor, a transparent, jelly-like substance, supported by numerous septa.

The *Hyaloid membrane* is a fine, transparent layer of connective tissue, enclosing the vitreous, and forms, by division anteriorly at the ciliary processes, the *suspensory ligament* of the lens. The *canal of Petit* is the name given to the space between the layers of the suspensory ligament at the periphery of the lens. Anteriorly the vitreous presents a well-marked depression, the *hyaloid fossa*, in which rests the posterior convexity of the lens. The vitreous is traversed in its antero-posterior axis in the fœtus by the *canal of Cloquet*, containing the *hyaloid artery*.

The *crystalline lens* is a biconvex and transparent body, varying in consistence at different ages, from 8–10 mm. in diameter and 3–4 mm. in depth at its axis. It is enveloped in front by the capsule, at its periphery by the suspensory ligament, and behind by the hyaloid. Its substance is arranged in concentric lamellæ, composed of minute fibrillæ, hexagonal in horizontal section (Fig. 7, 2). Between the lamellæ and among the fibres is an oil-like material, Liquor Morgagni, which permits of change of form without

friction. The concentric lamellæ are approximated by sutures, thus dividing the lens into sections along radiating planes. Considered as a whole, the lens consists of a *nucleus*, the almost structureless centre, and *cortex*, the outer fibrillary and softer portion.

FIG. 7.

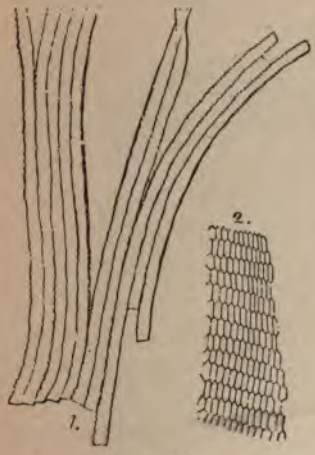


FIG. 8.

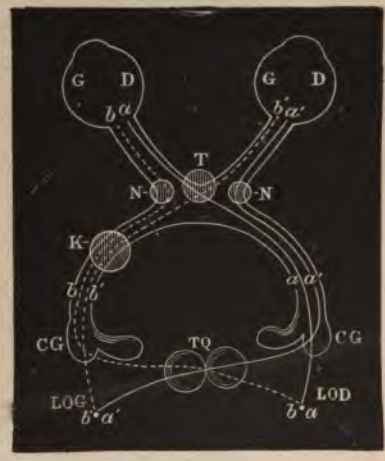


FIG. 7. FIBRES OF THE LENS.

2. Transverse sections of the lens fibres.

FIG. 8. DIAGRAM OF THE DECUSSATION OF THE OPTIC TRACTS.

T. Semi-decussation in the chiasma. *T, Q*. Decussation of fibres behind the ext. geniculate bodies (*C, G*). *a', b*. Fibres which do not decussate in the chiasma. *b', a'*. Fibres proceeding from the right eye and coming together in the left hemisphere (*L, O, G*). *L, O, G, K*. Lesion of the left optic tract, producing right lateral hemianopsia. *a*. Lesion in the left hemisphere, producing crossed amblyopia (right eye). *T*. Lesion producing temporal hemianopsia. *n, n*. Lesion producing nasal hemianopsia.

The *anterior capsule* is tough and elastic, and is lined on its posterior surface by a layer of hexagonal cells, whose function it is to nourish the fibres.

The fibres of the *optic nerves* (Fig. 8) arise in two bands, the *optic tracts*, from the corpora geniculata, corpora quad-

FIG. 9.

HORIZONTAL SECTION OF THE ENTRANCE OF THE OPTIC NERVE AND THE COATS OF THE EYE.

a. Inner, *b*. Outer, layers of the retina. *c*. Choroid. *d*. Sclerotic. *e*. Physiological cup. *f*. Central artery of retina in axial canal. *g*. Its point of bifurcation. *h*. Lamina cribrosa. *l*. Outer (dural) sheath. *m*. Outer (subdural) space. *n*. Inner (subarachnoid) space. *r*. Middle (arachnoid) sheath. *p*. Inner (pial) sheath. *i*. Bundles of nerve-fibres. *k*. Longitudinal septa of connective-tissue.

rigemina and ophthalmic ganglion, which are connected by radiating fibres with the cortical centre in the occipito-angular region of the cortex. Each optic tract winds obliquely across the corresponding crus cerebri, converges forward to meet its fellow on the opposite side, forming at their intersection the *optic commissure*, or *chiasm*. In the chiasm is a partial crossing of the fibres from each tract. The nerves arise from the chiasm, diverge, and each passes through the optic foramen in the corresponding lesser wing of the sphenoid bone. Each nerve is covered by prolongations of the membranes of the brain, which form its sheaths and between which are the intervaginal and subdural lymph-spaces. Just before the nerve reaches the *lamina cribrosa*, the network of connective tissue extending across the foramen sclera, the dura mater passes over into the sclera, the arachnoid and pia mater are discontinued, the medullary covering of the nerve fibres is dropped, and only the axes-cylinders pass through the foramen sclera and choroidea to form the nerve-fibre layer of the retina. Eighteen mm. posterior to this point, the ophthalmic artery and vein pierce the nerve obliquely, and having reached its centre, continue forward, and, passing through the porus opticus, are distributed to the retina.

NERVES.

The eyeball and its appendages are supplied by sensory branches from the first and second divisions of the fifth pair, motor branches from the third, fourth, sixth, and seventh pairs of cranial nerves, and sympathetic filaments from the carotid and cervical plexuses. The ciliary ganglion, lodged in the orbit below the superior and to the median side of the external rectus behind the ball, receives sympathetic fibres from the carotid plexus, sensory from the first or ophthalmic divi-

sion of fifth, and motor fibres from the third. From it a small twig joins the branch of the third, supplying the inferior oblique, and from three to six branches, subdividing into twenty, the *short ciliary*, enter the sclera around the optic nerve. The ophthalmic division of the fifth gives off three purely sensitive branches just before passing through the sphenoidal fissure; the *lacrymal*, accompanying the lacrymal artery, runs along the external rectus muscle to the lacrymal gland, supplying it, conjunctiva, and integument of the upper lid; the *frontal*, running forward above the levator palpebræ muscle, supplies by its two terminal branches the corrugator supercilii, occipito-frontalis, orbicularis palpebrarum, and the integument of the lids, forehead, and scalp; the *nasal*, passing through the orbit and giving off a twig to the ophthalmic ganglion, as well as two or more branches—the long ciliary nerves,—which perforate the sclera with the short ciliary, and run forward between the sclera and choroid to be distributed to the ciliary body, iris, and cornea; and the *infra-trochlear* to the conjunctiva and appendages of the eye.

The third nerve, motor oculi, supplies the internal, superior and inferior recti, inferior oblique, levator palpebræ, ciliary muscle, and iris, and furnishes a motor root to the ophthalmic ganglion.

The fourth nerve, trochlear, supplies the superior oblique.

The sixth nerve, abducens, supplies the external rectus.

The seventh nerve, facial, supplies the orbicularis palpebrarum.

ARTERIES.

The ball and its appendages (Fig. 10) are supplied with blood directly from the ophthalmic branches of the internal carotid, and indirectly by anastomoses between

its terminal branches and similar branches of the external carotid.

The *lacrymal* artery supplies the lacrymal gland, upper

FIG. 10.

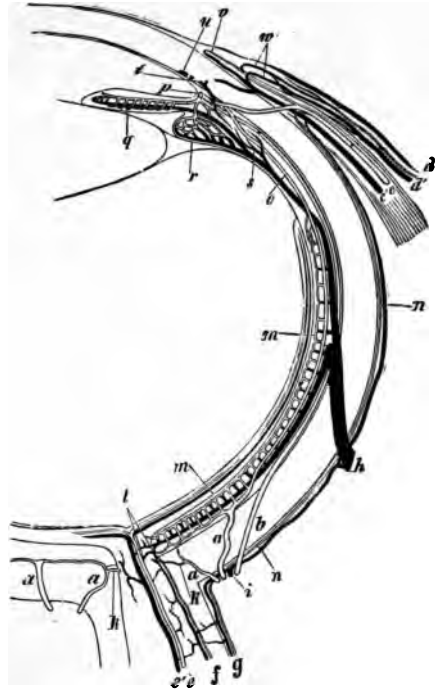


DIAGRAM OF THE BLOOD-VESSELS OF THE EYE. (*Horizontal view; veins black, arteries light, with a double contour.*)

aa. Short posterior ciliary. *b*. Long posterior ciliary. *cc'*. Anterior ciliary artery and vein. *dd'*. Artery and vein of the conjunctiva. *ee'*. Central artery and vein of retina. *f*. Blood-vessels of the inner, and, *g*, of the outer optic sheath. *h*. Vorticose vein. *i*. Posterior short ciliary vein confined to the sclerotic. *k*. Branch of the posterior short ciliary artery to the optic nerve. *l*. Anastomosis of the choroidal vessels with those of the optic nerve. *m*. Chorio-capillaris. *n*. Episcleral branches. *o*. Recurrent choroidal artery. *p*. Great circular artery of iris (transverse section). *q*. Blood-vessels of the iris. *r*. Ciliary process. *s*. Branch of a vorticose vein from the ciliary muscle. *u*. Circular vein. *v*. Marginal loops of vessels on the cornea. *w*. Anterior artery and vein of the conjunctiva.

lid, and conjunctiva; the *supraorbital*, the superior rectus and levator palpebræ muscles, inner canthus, skin and muscles of the forehead; the *two palpebral*, the lids; the *nasal*, a branch to the lacrymal sac; the *short ciliary*, pierce the sclera around the optic nerve and are the main supply to the choroid; the *long ciliary*, supply the ciliary body and iris; the *anterior ciliary*, given off from the muscular, perforate the sclera near the limbus, and supply the ciliary body and iris; the *two muscular*, supply the external ocular muscles.

LYMPH SYSTEM.

Lymph vessels, with their own walls, are found in the lids and conjunctiva, and empty into the parotid and submaxillary glands, accompanying the venæ facialis and temporalis. In the conjunctiva is a superficial and deep network of canals communicating freely with one another, and in close connection with the lymph systems of the cornea and sclera. The spaces in the cornea communicate probably with the great lymph space of the anterior chamber by means of Schlemm's canal and the spaces of Fontana. On the sclera lies another lymph space, *Tenon's capsule*, composed of two layers of delicate connective tissue, an inner, episcleral, and an outer, muscular layer. The inner lies immediately on the sclera as far forward as the insertion of the tendons, where it is reflected into the outer. Between the tendons it is carried forward nearer the cornea, and is there reflected. Both layers are lined with epithelium and extend backward to the foramen sclera, communicating with the intervaginal lymph space. Between the sclera and choroid is a third space, the *perichoroidea*, communicating with Tenon's capsule by fine canals through the sclera. The vitreous body and lens are nourished by the surrounding

blood-vessels of the uveal tract, and do not certainly possess lymph vessels proper, as does the cornea. In the fœtus, the lens is nourished by the *hyaloid artery*, which is given off from one of the branches of the arteria centralis retinæ, and pursues a straight course through the vitreous, terminating in fine branches on its posterior lenticular surface.

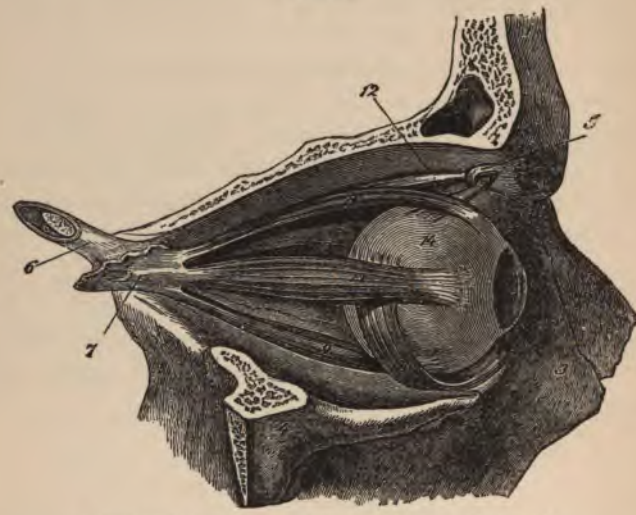
It is said that from the ciliary body a stream of lymph flows downward and backward through the vitreous, then forward and through the canal of Petit to the posterior chamber; downward and forward through the pupil into the anterior chamber, and outward to the angle, whence it escapes through the membrane of Descemet and ligamentum pectinatum to the canal of Schlemm. Tributary streams of lymph flow into the posterior chamber from the posterior surface of the iris and from the ciliary body, and into the anterior chamber from the anterior surface of the iris and meshes of Fontana's space. The corneal, scleral, conjunctival, perichoroidal, and Tenon's lymph spaces also communicate with the anterior chamber. The lymph canals of the retina accompany the retinal vessels and discharge through the porus opticus.

MUSCLES.

The position of the eyeball in the orbit is maintained and its movements governed by the action of six muscles, namely, four straight and two oblique. The recti, *superior*, *inferior*, *external*, and *internal*, and the *superior oblique* have a nearly common origin from the margin of the optic foramen in the lesser wing of the sphenoid bone. The recti, diverging in the directions indicated by their names, run forward parallel to the orbital wall, perforate the capsule of Tenon, and are inserted into the sclera at distances varying from six

to eight mm. from the cornea. The *superior oblique* passes forward and upward to the upper and inner angle of the orbit, thence through a bony and cartilaginous pulley outward and backward under the superior rectus, to be inserted into the sclera on its posterior and superior surface. The *inferior oblique* arises from a depression in the superior

FIG. 11.



LATERAL VIEW OF THE MUSCLES OF THE EYEBALL.

5. Trochlea or pulley of the superior oblique muscle. *1*, *2*, *6*. Optic nerve. *8*. Superior, *9*, inferior, and *12*, external rectus. *13*. Inferior oblique.

maxillary bone at the inferior and anterior angle of the median wall of the orbit, passes outward and backward under the globe, and is attached to the sclera on its external and posterior surface.

The *levator palpebræ* arises from the upper portion of the bony wall of the optic foramen, passes forward and upward

to be inserted into the cartilage of the upper lid. Its function is to elevate the lid.

The *orbicularis palpebrarum* is a broad, circular muscle, arising from the inner canthus and from the soft tissues immediately adjacent to the nose, passes under the skin of the lids and between them and the orbital ridges, and is inserted close to its origin. By its contraction the lids are closed.

The *optic axis* is a line drawn from the centre of the cornea to the centre of the retina. The ends are called respectively anterior and posterior poles.

The *visual* axis is a line drawn from the fovea centralis to the object in view.

The *angle* α is formed at the intersection of the visual with the optic axis. In H.* it is usually larger and may cause an apparent divergence. In M. it is small, or may be absent (negative), *i. e.*, the optic and visual axes coincide. This may give rise to the appearance of convergence. The *angle* γ is at the centre of rotation of the ball, and is the angle formed at the junction of a line drawn from the centre of rotation to the object in view with the optic axis.

THE APPENDAGES OF THE EYE.

The lids (Fig. 12) are composed of skin, muscle, dense, fibrous tissue or cartilage, the *tarsus*, and mucous membrane. The cutaneous layer of the upper lid, containing partly-developed papillæ and numerous fine hairs and some sweat glands, is loose and distensible; at the margin it becomes modified, and is continued on the under surface, where it becomes mucous membrane. Connective tissue in wide meshes, highly vascular, separates the in-

* Abbreviations: E. Emmetropia. H. Hypermetropia. M. Myopia. As. Astigmatism.

FIG. 12.

VERTICAL SECTION THROUGH THE UPPER EYELID.

A. Cutis; 1. Epidermis; 2. Corium; *B*. and 3. Subcutaneous connective-tissue; *C*. and 7. Orbicularis muscle; *D*. Loose submuscular connective tissue; *E*. Insertion of H. Müller's muscle; *F*. Tarsus; *G*. Conjunctiva; *J*. Inner, *K*. Outer edge of the lid; 4. Pigment cells; 5. Sweat-gland; 6. Hair follicles; 8 and 23, Sections of nerves; 9. Arteries; 10. Veins; 11. Cilia; 12. Modified sweat-glands; 13. Circular muscle of Riolan; 14. Meibomian gland; 15. Section of an acinus of the same; 16. Posterior tarsal glands, submuscular connective tissue; 21 and 22. Conjunctiva, with its epithelium; 24. Fat; 25. Loosely-woven posterior end of the tarsus; 26. Section of a palpebral artery.

tegument from the second or muscular layer, the lid portion of the orbicularis palpebrarum. The tarsus of the upper lid consists of dense, closely-interwoven fibrous tissue, connected rather loosely with the muscle above and closely with the mucous membrane below. It is 9 mm. in height, 20 mm. in length, and .8 mm. in thickness. Into its upper margin is inserted the tendon of the levator palpebræ. The lower border is free and in its substance are found tarsal or meibomian glands and hair follicles, the ciliæ.

In the lower lid the cartilage is almost undeveloped, and the glands are fewer and relatively insignificant.

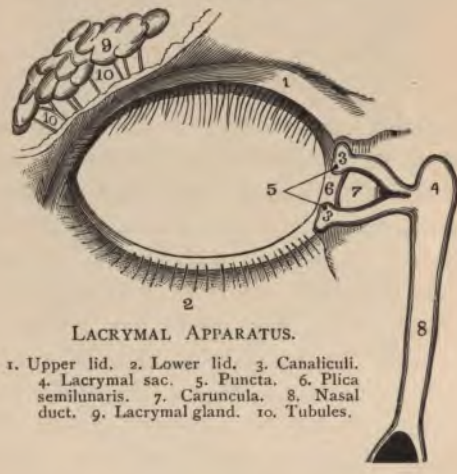
CONJUNCTIVA.

The conjunctiva, continuous with the Schneiderian mucous membrane of the nose and the integument of the lids at their free margins, is a mucous membrane composed of columnar epithelium with its basement membrane, and is richly supplied with vessels and nerves. It is divided into *palpebral*, the portion lying in juxtaposition to the lid; *fornix*, the upper and lower cul-de-sac, where the conjunctiva leaves the lid and is reflected over into the sclera, and *ocular*, the portion lying on the ball. The epithelium is continued over the cornea, forming its first layer, while the loose, connective tissue ends at the corneo-scleral margin. The palpebral portion is thick, contains numerous papillæ and glands, and is highly vascular. The ocular conjunctiva is less dense, loosely connected with adjacent parts, and transparent. The conjunctiva forms a small fold at the inner angle, the *plica semilunaris*, adjoining which on the nasal side is a small conical body, *caruncula lacrymalis*, composed of muscular fibre, fat, and mucous membrane, and supporting a few fine hairs.

LACRYMAL APPARATUS.

The *lacrymal gland*, which secretes the tears, is held by a few fibrous bands in a depression in the frontal bone at the upper and outer angle of the orbit. Its under surface rests upon the ball and adjacent portions of the superior and external recti muscles. It is about the size and shape of an almond, and opens into the outer and upper fornix by a

FIG. 13.



LACRYMAL APPARATUS.

1. Upper lid. 2. Lower lid. 3. Canaliculi. 4. Lacrymal sac. 5. Puncta. 6. Plica semilunaris. 7. Caruncula. 8. Nasal duct. 9. Lacrymal gland. 10. Tubules.

number of tubules, through which the tears are conveyed into the conjunctival sac. From this point, tears flow over the conjunctiva and cornea, cleansing and lubricating these parts, and are forced by winking into the *puncta lacrymalia*, two small openings opposite one another near the nasal extremity of the ciliary borders of upper and lower lids; thence into the *canaliculi*, two small canals 12 mm. long, by

which they are conveyed into the *lacrymal sac*, the expanded upper extremity of the nasal duct. The sac is lodged in a depression formed by the lacrymal and nasal process of the superior maxillary bone, and is covered and compressed by the *tendo-tarsi* muscle and by the fibrous expansion of the *tendo-oculi*. From the sac the tears pass into the *nasal duct*, a membranous and bony canal, 20 mm. long, emptying into the inferior meatus of the nose.

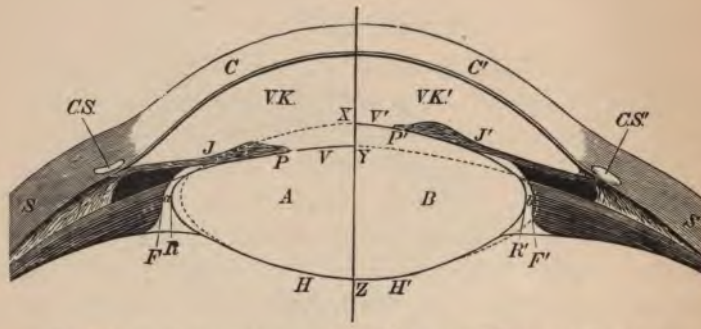
ACCOMMODATION.

By accommodation is meant the power that resides in the ciliary muscle of so altering the length of the antero-posterior diameter of the lens, that the eye becomes adapted in its focal length to any distance within infinity. By contraction of the radiating fibres of the ciliary muscle toward their fixed points in the choroid, the angle of the anterior chamber is drawn inward and backward, while the diameters of the lens are simultaneously shortened by the contraction of the circular fibres of the same muscle. The effect of this double contraction is to relax the suspensory ligament of the lens. Thus in the act of accommodating the lens is increased in convexity, the iris is contracted, and the anterior chamber becomes shallower. (Fig. 14.)

Accommodation is said to be positive or negative. It is positive when the ciliary muscle contracts in the manner just described, and negative when the refracting power of the lens is diminished instead of increased, and this is accomplished, theoretically, by supposing the angle of the anterior chamber to be the fixed and the choroid the movable points, inducing a flattening of the lens or a positive diminution in the antero-posterior diameter of the vitreous by a dragging forward of the choroid and retina.

The range of accommodation is the distance from the far point, *r*, to the near point, *p*. The *amplitude* of accommodation is the accommodative effort of which an eye is capable, and is equal to the difference between the refraction when the eye is at rest, or adapted for its far point (*r*), and when the accommodation is exercised to its fullest extent (*p*). Hence $a = p - r$. Example: in emmetropia,

FIG. 14.



SCHEME OF ACCOMMODATION FOR NEAR AND DISTANT OBJECTS.

The right side of the figure represents the condition of the lens during accommodation for a near object, and the left side when the eye is at rest. The letters indicate the same parts on both sides; those on the right side are marked with a dash. *A*. Left, *B* right half of the lens; *C*. Cornea; *S*. Sclerotic; *CS*. Canal of Schlemm; *VK*. Anterior chamber; *J*. Iris; *P*. Margin of the pupil; *V*. Anterior surface; *H*. Posterior surface of the lens; *R*. Margin of the lens; *F*. Margin of the ciliary processes; *a* and *b*. Space between the two former; the line *ZX* indicates the thickness of the lens during accommodation for a near object; *ZV*. The thickness of the lens when the eye is passive.

$p = 6$ cm., $r = \infty$ (infinity); $a = 6$ cm. $- \infty$; $a = 6$ cm., or its range extends from infinity to a point 6 cm. from the eye. Its amplitude or power expressed in diopters is obtained thus: 6 cm. divided into 100 = 16.6 diopters. In other words, a convex glass, 16.6^{D} placed before the eye makes parallel the rays which diverge from the near point and substitutes the greatest contraction of the ciliary muscle.

Relative Accommodation.

Accommodation and convergence bear a constant relation to one another, within the limits of the amplitude of accommodation on the one hand and the amplitude of convergence on the other. Thus with the visual lines parallel, accommodation may be determined by placing before the eyes minus glasses of constantly increasing strength. The highest number that can be overcome, vision always $\frac{6}{6}$, is the measure of the accommodation exercised independently of convergence. Convergence, when accommodation remains unchanged, may be estimated by prisms. The strongest prism, angle in, through which binocular vision is maintained at 6 m., is the measure of the limit of the converging power, independent of accommodation. The strongest prism, angle out, through which single vision is maintained under the same conditions, is the measure of the limit of minus convergence.

The Metre Angle.—For every distance nearer than 6 m., convergence bears a fixed relation to accommodation. Thus, by the exercise of 1 D. of accommodation in emmetropia, the internal recti so direct the visual axes that they cross at 1 m. from the basal line uniting the two eyes, and form with the perpendicular to that line at its centre, an angle, called the *metre angle.* By the exercise of 2 D. of accommodation, the convergence will equal two metre angles, with 3 D. of accommodation it will equal three metre angles, and so on. Again, if the object is situated at 1 m., convergence will equal one metre angle, if at 50 cm., it will equal two metre angles, etc.

TEST CARDS, TEST LENSES, ETC.

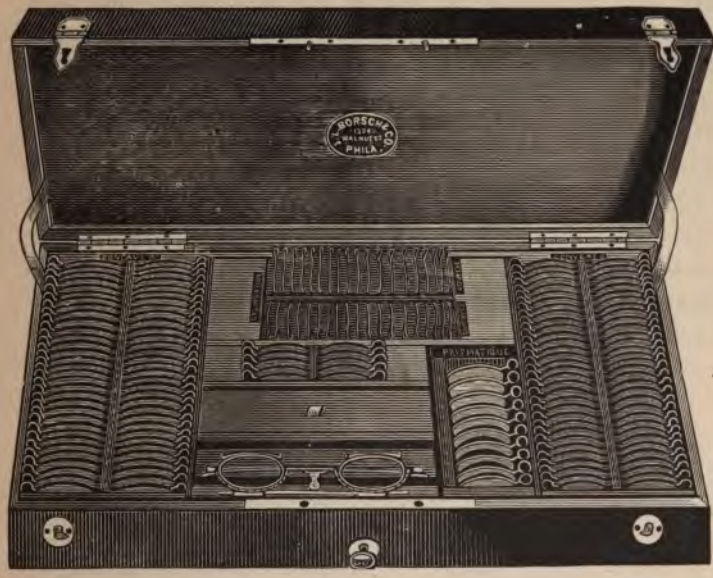
The test letters commonly in use are so constructed that their vertical diameter shall be the sine of the angle of 5′. Suppose two lines are drawn, one from the top and the other from the bottom of such a letter, so that they meet in the lens of an eye. They are not mathematically parallel, but they are so nearly parallel that the angle of 5′ which they form with each other, at their crossing point in the posterior part of the lens, is disregarded, and they are considered parallel. This angle is chosen, because it is the smallest which includes recognizable objects. But mathematically parallel rays can come only from an object at an infinite distance. Hence we say that all objects included in the lines forming this angle are at an infinite distance. The farther removed from the eye the greater the size of such objects must be, although their images on the retina are of the same size. Thus, the card—

50	B N	$= \frac{1}{10}$
40	E R	$= \frac{1}{8}$
30	N C D	$= \frac{1}{6}$
20	P R F H	$= \frac{1}{4}$
15	L C B D T	$= \frac{1}{3}$
10	E P G B U	$= \frac{1}{2}$
7½	B L R P V P E	$= \frac{2}{3}$
5	T C N D E O F	$= 1$

The extremities of the vertical lines of B N measure the sine of the angle of 5′ at 50 m. The normal eye sees B N at 50 m., but at no greater distance; E R at 40 m., but at no greater distance; T C N D E O F at 5 m., but at no greater distance. The *acuity* of *vision* is expressed by a fraction, the numerator of which is the distance of the

patient from the test-card, and the denominator the line he reads at that distance. Hence, normal acuity equals $\frac{5}{5}$, $\frac{6}{6}$, or 1. A diminished acuity would be, for example, $\frac{6}{10}$, $\frac{6}{50}$. If the acuity should be so low that B N cannot be seen at 5 m., we must bring the card closer to the patient or use larger letters.

FIG. 15.



TEST CASE.

The metric system of numbering lenses according to their refracting power and not according to their focal length, as in the obsolete inch system, is now universally employed by properly equipped ophthalmic surgeons and opticians. A lens which will bend parallel rays of light to a focus at the distance of 1 m. is called "1 Diopter,"

expressed 1 D. The word diopter, literally signifying the refractive media of the eye, is transferred to the glass. One-half diopter (.50 D.) will focus parallel rays at the distance of 2 m., 2 D. at ½ m., 3 D. at ⅓ m., 4 D. at ¼ m., etc. The weakest lens ordinarily used is .25 D., 4 m. in focal length, and the strongest 20 D., 5 cm. in focal length.

The refracting power of a minus lens, negative focal length, is the same as that of a plus lens of the same number.

The cylinders are plus and minus, and are marked like sphericals, in strengths from .25 D. to 6 D. Higher strengths, which are seldom required, may be obtained by superimposed cylinders, whose sum is the refracting power desired.

The frame for holding lenses before the patient's eyes, consists essentially of two circular lens-holders, marked in degrees from 0 to 180, held together by a nose-piece and a horizontal bar, along which they can be moved.

FIELD OF VISION.

When refraction and accommodation are normal and the media clear, subnormal vision is attributable to some lesion of the retina, choroid, optic nerve or cerebro-spinal system, and when this is the case, it becomes necessary to accurately measure the field of vision, the area over which objects can be seen while the eye remains fixed on a given point. The objects thus bounded by the ultimate range of peripheric vision without changing the direction of the visual line, mark the limits of the visual field, which may be contracted in various ways under pathological influences. The field may be concentrically smaller, it may be diminished or altogether lost on the nasal or temporal side—horizontal hemianopsia;

the superior or inferior fields may be similarly affected, vertical hemianopsia, or irregularly shaped defects may be found in its centre or elsewhere, scotomata.

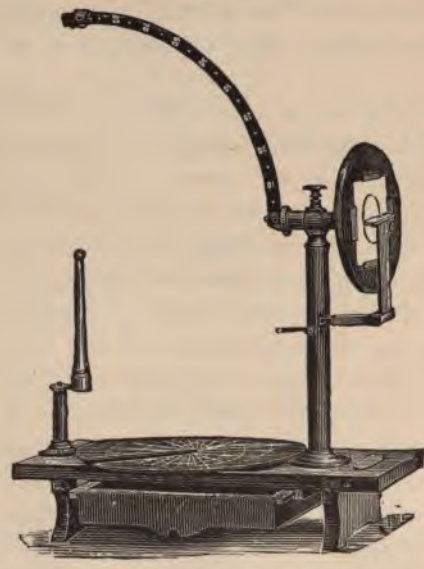
The sensibility of the retina rapidly diminishes from the fovea to the periphery, and it should be remembered that the bridge of the nose considerably limits the visual field in its inner half, and that the optic disc projects a blind spot of proportionate size to the temporal side of the fixation point, but when the normal field is diminished in any particular section, there is lessened sensibility of the retina.

The visual field may be approximately measured by directing the patient to sit facing and about twelve inches away from a blackboard in the centre of which a small white cross is marked with a piece of chalk, and to look steadily at this cross with the eye under examination, the other eye being closed, while the examiner with a piece of chalk attached to a dark handle marks on the blackboard the points, in all meridians, at which it fades from peripheric vision. The point at which the patient first sees the chalk as it is moved toward the centre, or at which it disappears from view when moved from the centre, is marked on the blackboard, and is a measure of the visual field. The *quantitative* field of vision thus determined is not to be confounded with the central smaller area, or *qualitative* field, in which small objects, such as letters, are discernible.

The perimeter, a simple and comparatively inexpensive instrument, exactly defines the field of vision, and its employment has very generally superseded measurements by the earlier and clumsier methods. It consists essentially of an arc comprising a quadrant, or semicircle, marked in degrees, and adjustable at any angle, and an upright bar to

which is attached a movable chin rest. On the arc, in the axis of the instrument, is a white mark or cross, thirty cm. from patient's eye, and a sliding clip containing white or colored test. The white test should be eleven mm., and the blue, red and green five mm. in diameter. The patient's gaze is directed toward the cross while the clip is moved from

FIG. 16.



McHARDY'S PERIMETER.

the centre toward the periphery. The point at which it disappears from the patient's vision is the limit of the perception of the retina in that direction. A chart is thus made and the visual field for white and colors measured in degrees. The limit of the normal field, subject to variations according to the conformation of the

face, for white, blue, red and green, is illustrated in the following table:—

	White.	*Blue.*	*Red.*	*Green.*
Externally,	70°–90°	65°	60°	40°
Internally,	50°–60°	60°	50°	40°
Upwards,	45°–55°	45°	40°	30°–35°
Downwards,	65°–70°	60°	50°	35°

(*Landois and Stirling.*)

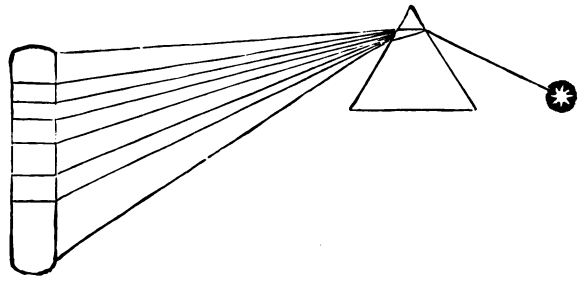
COLORS.

Solar light, which is uniform and colorless, is transmitted through what we vaguely term the luminiferous ether in transverse waves of varying length, which, separated, give rise to certain visual impressions that are the source of all color sensations. The dispersion of a beam of light into its separate wave-lengths is effected by means of a prism, which disposes them, refracting each ray in proportion to the shortness of its wave, in a colored spectrum, or band, from which they can by reversion through a similar prism be reformed into a beam of colorless light. Without going into a discussion of the Young-Helmholtz, or Hering theories of color vision, which are elaborated in the larger text-books on Physiology, it may be stated that the so-called *spectrum colors* so shade off, one into the other, that their division by name is largely a matter of arbitrary arrangement. Red, blue, and yellow are regarded as *primary colors*, and form, by combination, *secondary colors*, that is to say, combinations of blue and red will give purple and violet; yellow and red combined give orange; and blue and red combined make green. Our color sensations admit of certain other relations and combinations of colors, giving by association in one case, and disassociation in the other, respectively *complementary*, and *contrast* or *confusion colors*.

Color Sense is quickly and most accurately determined

by the distinction and separation of various colors without designating them by name. For this purpose it is usual to employ Holmgren's worsteds, a set of skeins of wool made up of the primary, secondary, and confusion or mixed colors. Among them are three large skeins, a *light green*, a *light purple*, and a *scarlet red.* The patient is first asked to match the green, which the examiner does not designate by name. If blind for green, he will confuse with it grays, browns, yellows and drabs. Or if blind for red, he will choose purple, blue and light shades of violet,

FIG. 17.



SPECTRUM OBTAINED BY MEANS OF A PRISM.

red, gray and green. If the patient's color sense is normal, there will be no confusion of the colors in separating the skeins.

COLOR-BLINDNESS.—The question of congenital achromatopsia, or color-blindness, has acquired considerable importance of late years, or since the discovery of the fact that about 1 in 25 of the entire male population is partially affected by it. The proportion of color-blind is significantly small in women, being about 1 in 400. The defect usually is not suspected until its presence is revealed by

examination. Railway men, sailors and soldiers are almost universally compelled to undergo an examination for color-blindness previous to employment.

Acquired achromatopsia is an occasional symptom of disease of the optic nerve, or of hysterical amblyopia, and is treated under these heads.

PART II.

PHYSIOLOGICAL OPTICS.

Light proceeds from all luminous bodies through "the ether," a medium independent of the atmosphere, by undulations of inappreciable height. The principal source of light is the sun. We conceive that all visible objects consist on their surface of innumerable luminous points from which rays of light travel in all directions. It follows that some of the diverging rays from each luminous point must enter the pupil of the eye in straight parallel lines. Rays are assumed to be parallel, in physiological optics, that proceed from a small object removed 6 m. or more from the eye, and an object thus far removed, is said to be at an infinite distance.

Reflection is the bending or turning back of a ray of light from a surface that neither absorbs, transmits, nor scatters it.

Refraction is the deviation of light from a straight line in passing obliquely through transparent media of different densities.

The index of refraction of a substance expresses in numbers the relative power that medium possesses of bending oblique rays of light which pass through it, away from the direction pursued by them before entering it, or the ratio of the sine of the angle of incidence to the sine of the angle of refraction. The index of refraction of air is taken as 1, that of water, as 1.336 (sin. : i. : sin. : r. : : 4 : 3); that of glass, as 1.535 (sin. : i. : sin. : r. : : 3 : 2).

In passing from one medium to another of different density—air to glass—a ray of light, *a a*, entering the second medium perpendicular to its surface continues its course unchanged. (Fig. 18.) On the other hand, an oblique ray, *b*, passing from a lighter to a denser medium, *m*, is bent toward the perpendicular, and from a denser to a lighter medium away from the perpendicular, and if the two sides of the refracting medium are parallel, the emerging ray, *b*, pursues its course parallel to the incident ray, simply undergoing parallel displacement.

FIG. 18.

REFRACTION BY MEDIUM WITH PARALLEL SIDES.

The angle of incidence, *x*, equals the angle of emergence, *y*.

The incident and emergent rays are not parallel, however, when a ray of light traverses a medium with non-parallel surfaces, but are angularly displaced. In physiological optics we simply apply the law of angular deviation experienced by a ray of light in its course through a medium of non-parallel surfaces. This law is best studied in the action of a prism upon rays of light.

Thus (Fig. 19), in the prism *m*, *b* is the incident, and *b'*

the emergent, ray. It is thus shown that the rays of light are always bent toward the base of the prism, while the source of the rays is apparently displaced toward the apex, *a*. The angle formed by the meeting of the prolongation of the incident and emergent ray is the angle of deviation, and is about one-half the size of the apex angle.

Prisms are numbered according to the number of degrees included in the apex. A new nomenclature by which they shall be numbered according to their refractive power, or size of angle of refraction, is under discussion.

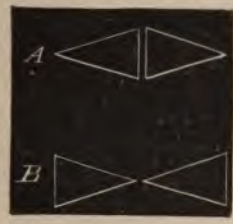
FIG. 19.

REFRACTION BY A PRISM.

The lenses used for the correction of spherical errors of refraction are of two kinds (Fig. 20), and may be practically considered as formed by two juxtaposed prisms which, joined by their bases, form *convex*, and, by their apices, *concave* lenses. Bearing in mind that in the case of a lens, as in a prism, the rays are always refracted toward its base (thickest portion), the subject is greatly simplified. It is obvious that rays of light are made to *converge* by the action of a convex, and to *diverge* by the action of a concave, lens.

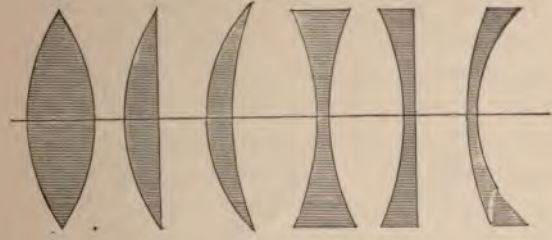
The lenses commonly used in ophthalmic practice are made of flint glass or pebble rock crystal, and form either the segment of a sphere, *spherical* glasses, or the segment

FIG. 20.



of a cylinder, *cylindrical* glasses. Both influence alike the course of rays, but spherical glasses having a centre of curvature form images, while cylindrical glasses, having no

FIG. 21.

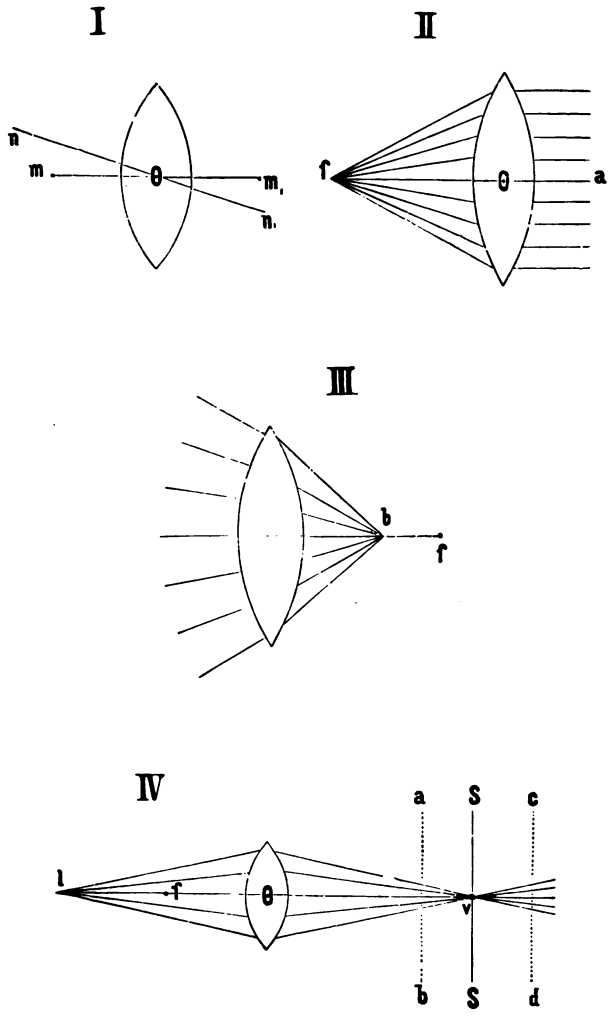


DIFFERENT FORMS OF SPHERICAL LENSES.

curve parallel to their axes, focus all incident rays into a line parallel to the axis of the cylinder.

Six modifications of spherical lenses are employed—double convex, plano-convex, converging concavo-convex,

FIG. 22.



REFRACTION OF PARALLEL, DIVERGING AND CONVERGING RAYS BY CONVEX LENS.

or parabolic, double concave, plano-concave, and diverging concavo-concave. In Fig. 21 these lenses are shown in the order named, from left to right.

The centre of the lens is called the *optical* centre, o, (Fig. 22, I). The principal axis, m m, is a line passing through the optical centre perpendicular to the surface, and is not refracted. All other rays are refracted, but those passing through the optical centre undergo but slight refraction, emerge in the same direction as they entered, and are called *secondary axes*, n n.

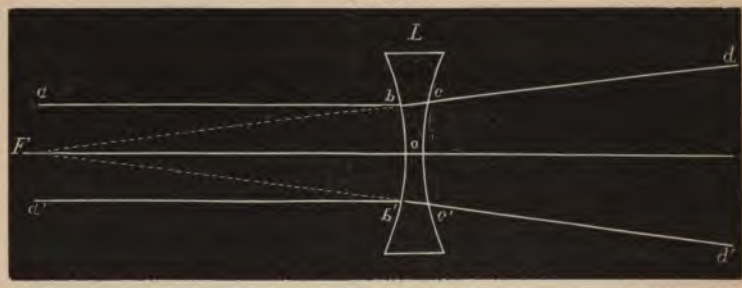
Rays of light in passing through a convex lens parallel to its axis, a, II, converge to a point on its distal side, the *principal focus*, f. The distance from the centre of the lens to the principal focus is the *focal distance* of the lens, o f, and the degree of bending, or the refraction of the rays, as controlled by the index of refraction and the curve of the surfaces, is the refracting power. Converging incident rays also come to a focus, b, III, on the distal side at a point nearer to the lens than its principal focus, f, and diverging incident rays focus to a point, l, IV, which is farther removed than the principal focus, f. It follows that incident rays diverging from the principal focus emerge in parallel lines; that incident rays diverging from a point nearer to the lens than its principal focus, diverge on emerging; and, lastly, that incident rays diverging from a point farther from the lens than its principal focus, converge on emerging.

The nearer the principal focus the greater the refracting power of the lens.

Concave Lenses and their Action on Rays of Light.—In passing through a concave lens, parallel rays a b, a′ b′ (Fig. 23), are rendered divergent, c d, c′ d′, as if proceeding from a point F on the line of the principal axis between and on the same side of the lens with the parallel incident

rays (negative form). This point is the *virtual focus*, and its distance from the lens is the measure of its *negative focal length.* Rays diverging from the principal focus are ren-

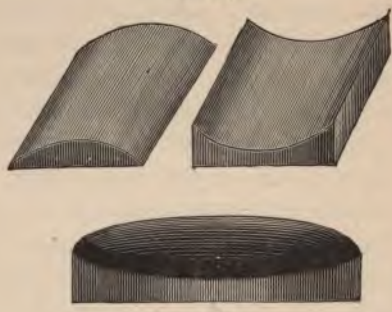
FIG. 23.



dered still more divergent, and converging rays are rendered less converging.

A cylinder (Fig. 24) having its curve in one direc-

FIG. 24.



CYLINDERS.

tion only, must refract rays of light in one direction, namely, in its axis, or in the line passing through the summit of the curve in a convex, and the depth of the depression in a con-

cave, cylinder, at right angles to the curve. Let us imagine the cylinder is composed of an infinite number of curved lines in juxtaposition, each one being just wide enough to admit of a single beam of light. Each line will then focus each beam to a point, but the lines are in juxtaposition, hence the points of focus must also be in juxtaposition. Since a line is made up of points, the focus of a cylinder must be a line. The refracting power, focal distance, and other qualities of a cylinder, are spoken of in the same meaning as of a spherical lens, always bearing in mind the fact that it focuses in a line and not in a point. The minus cylinders have negative qualities, as the minus sphericals.

Around the lens-holders in the test frame is a semicircle marked in degrees, and one end of the axis of the cylinder may be turned to any desirable degree. Hence we say, *cyl. ax. 90°*, or *ax. 180°*, or *ax. 135°*, etc. When adjusted to the patient's face, the left extreme end is arbitrarily chosen as 0°, the right or opposite end as 180°, and between these extremes, the semicircular bar is marked at intervals of 5°.

The *dioptric system*, or the refracting media of the eye, which influences the course pursued by rays of light, is composed of structures which differ in density and in the curvature of their surfaces, but it suffices, practically, to average the refracting indices of the several factors, and to consider them as forming, in combination, a double convex lens. A double convex lens of this description is found by intersecting the cornea by an imaginary line continuous with the posterior surface of the lens. The focal length of the combined surfaces thus formed is 22.23 mm., and the media have a common index of refraction of 1.33.

Parallel rays impinging upon the cornea of a normal (emmetropic) eye, are brought to a focus upon the retina in the absence of accommodation. Under the same condi-

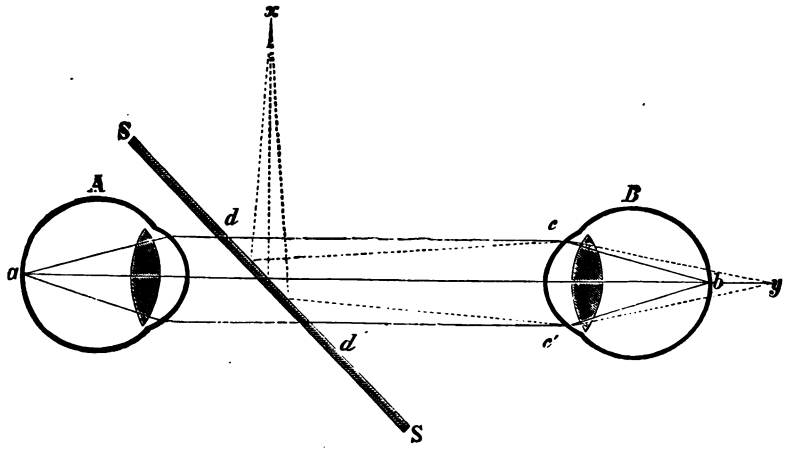
tion of rest, diverging rays will come to a focus, theoretically, at a point behind the retina, and converging rays will come to a focus at a point in front of the retina. Therefore, in a normal eye at rest, rays which proceed from the focus upon the retina will emerge out of the cornea parallel, those from behind the retina converging, and those from in front of it diverging.

In examining the fundus of an eye by the ophthalmoscope, the foregoing optical principles are observed. For instance, if the observer's eye is of normal refraction, and at rest, not accommodating, the details of the fundus of the eye under observation will be seen, provided the observed eye is also suitably illuminated, at rest, and normal in its refraction. Without the aid of artificial light the reflection of light from the observed eye, which is projected along the visual axis of the two eyes, is too feeble for illumination, and the pupil appears black. The pupil of observed eye will still appear black when a light is interposed in the line of vision between it and the observing eye, since the two eyes are adapted to parallel rays only, and the diverging rays from the interposed light would illuminate both eyes, and the returning rays would focus at the interposed light, as if proceeding from a point behind the retina, and an inverted image of the interposed flame would be focused upon the retinæ of the two eyes. Therefore, it is not only necessary, in order to see the fundus of the eye under examination, that the observed and observing eyes shall be artificially luminous, but also that the light shall be placed in such a position that its flame will be effective as a source of illumination.

This necessary arrangement of the light was first accomplished by Helmholtz, who constructed an instrument by which the light was suitably placed behind the observed

eye. The invention of this instrument, the ophthalmoscope, has placed ophthalmology among the fixed sciences, and given to its study and practice an interest and effectiveness surpassed by no other department of the medical sciences. Prior to its discovery, the appearance in the living subject of the intra-ocular tissues was unknown. Indeed, our knowledge of the subject was of a kind with the belief, universally held and taught at that time, that there was complete absorption of the light entering the eye.

FIG. 25.



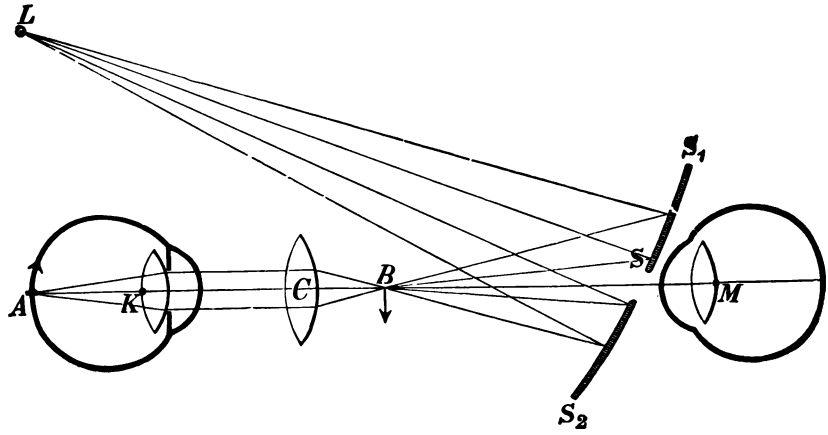
DIRECT EXAMINATION BY OPHTHALMOSCOPE.

EXAMINATION BY THE OPHTHALMOSCOPE.—There are two methods of examining the eyes by the ophthalmoscope, the *direct* and *indirect*.

By the former (Fig. 25), a real, erect, and four-fold magnified image is seen by the observer. A is the observing, B the observed eye, SS the plane mirror, and x the source of illumination. The rays of light from x impinge

upon the mirror and are reflected along the dotted lines *c d c'd'* into *B*, illuminating the fundus. *A*, looking through opening in *SS*, along the line of the reflected rays, sees *B*'s retina around *b*. The dotted lines come to a focus behind *b* at *y*. But *b* is now the source of illumination, and rays emerging out of *B* pursue a parallel course and are focused by the dioptric apparatus of *A* at *a*.

FIG. 26.



INDIRECT EXAMINATION BY OPHTHALMOSCOPE.

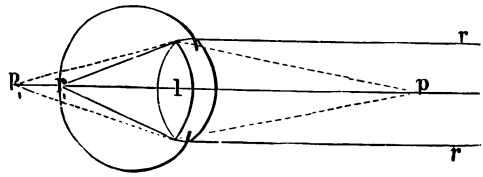
By the indirect method, an inverted image is formed in the air by the interposition of a strong convex lens (14^D–20^D) (Fig. 26). *M*, observer's, *K*, observed eye; *S*, the mirror. Rays from the mirror *S*, pass through the lens *C* (the refraction of these rays is not shown in figure), enter *K*, and strike on the retina at *A*. On returning and being refracted by the media of eye *K*, rays enter the lens *C*, and are focused by it at *B*, forming an inverted aerial image, of a portion of *K*'s retina.

PART III.

REFRACTION.

Normal refraction is dependent on three conditions: (1) on the antero-posterior diameter of the globe, (2) the transparency of the refracting media, and (3) the curve of their surfaces. When an eye is of the right length antero-posteriorly, the refracting media clear, and their surfaces normal in curvature, parallel rays of light are brought to a focus on the percipient layers of the retina, the rods and

FIG. 27.



CONDITION OF REFRACTION IN THE NORMAL PASSIVE EYE AND DURING ACCOMMODATION.

cones, and the refraction is normal. The refraction is abnormal when parallel rays of light are not brought to a focus on the retina in the absence of accommodation.

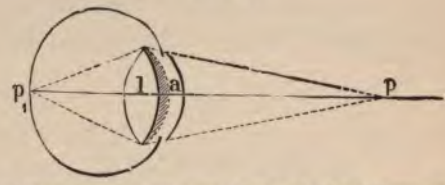
EMMETROPIA is the term used to denote normal refraction. In an emmetropic eye, parallel rays of light, *r r*, are brought to a focus (Figs. 27, 28) on the retina, r_1, without accommodation, and diverging rays proceeding from a point, *p*, nearer than infinity, are brought to a focus on

the retina, p_1, by the exercise of a normal amount of accommodation. Such an eye, to be exact, will recognize any properly illuminated object whose height is equal to the sine of an angle of 5′. An emmetropic eye of normal acuity of vision is an extremely rare condition, about four per cent.

A normal refraction and a normal eye are distinct and separate conditions, and should not be confounded. An eye may be of normal refraction and yet be blind from disease.

AMETROPIA is a generic term used to express variations

FIG. 28.



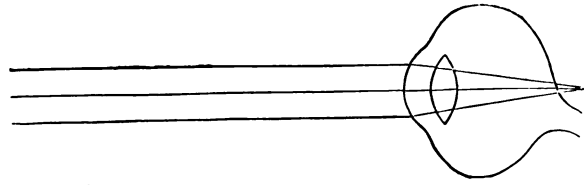
CONDITION OF REFRACTION IN THE NORMAL EYE DURING ACCOMMODATION.

from the normal refraction, and has no reference to the kind or degree of refractive error. An ametropic eye may be hypermetropic, myopic, or astigmatic.

HYPERMETROPIA, HYPEROPIA (Fig. 29), is the most prevalent form of ametropia, and is that condition of refraction in which parallel rays of light are never focused when the eye is at rest, that is to say, when the eye is not accommodating. The curvature of the cornea and of the lens, one or both, is so altered that parallel rays are intercepted by the retina before they converge to a focus. In other words, the antero-posterior diameter of the eye, the distance between the apex of the cornea and the layer of rods and

cones, is too short. Such an eye is adapted to converging rays. By contraction of the ciliary muscle, the curvature of the anterior, and possibly the posterior, surface of the lens is made more convex, and its antero-posterior diameter is thus increased. In emmetropia this contraction of the ciliary muscle, accommodation, is only necessary for the perception of points of an object nearer the eye than six metres. In hypermetropia, on the other hand, no point can be seen at any distance without accommodation. Hypermetropia is said to be *latent* when it is concealed by constant contraction of the ciliary muscle; and hyper-

FIG. 29.



HYPERMETROPIC EYE.

metropia which the contraction of the ciliary muscle, or accommodation, cannot overcome is said to be *manifest.* The sum of the two, latent and manifest, constitute the *total* hypermetropia. The degrees of latent and manifest hypermetropia depend on the power of accommodation, the elasticity of the crystalline lens, and on the length of the globe antero-posteriorly. The total hypermetropia depends on the antero-posterior diameter of the eye alone.

The symptoms of latent hypermetropia will depend on the age, sex, occupation, and on the acquired and hereditary predisposition of the patient. A well-marked case will complain of headache, either constant or following near

use of the eyes, pain in the eyes, blurring of letters in reading, and lacrymation. No complaint will be made of bad vision. The diagnosis may be partially made by the ophthalmoscope, but it can only be completely and satisfactorily determined by retinoscopy, or by test lenses after the accommodation has been paralyzed by a mydriatic. Let us illustrate this by a case: A young man, clerk, age twenty, has suffered for several years from a nearly constant headache, which is aggravated by his long hours of office work. General treatment and hygiene have afforded no relief, and he has given up reading at night on account of consequent pain. V. $= \frac{6}{6}$, made worse by plus, perhaps improved by weak minus lenses. Ophthalmoscope shows normal fundus. Headache relieved in three quarters of an hour after instillation of Duboisine, gr. ij-$\bar{3}$j, but V. declined to $\frac{6}{18}$. Ophthalmoscope gives $+ 2^{D}$, Retinoscopy $+ 2^{D}$, and $+ 2^{D} = \frac{6}{6}$. Latent Hypermetropia $= 2^{D}$. By means of constant over-action of the ciliary muscle, the patient was enabled to increase the antero-posterior diameter of the lens two diopters.

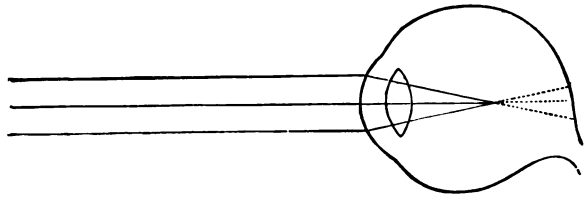
The symptoms of combined manifest and latent hypermetropia, are defective vision, blurring of letters in reading, headache, and pain in eyes, aggravated by their use in near work. *Case*:—V. $\frac{6}{12}$, $+ 1^{S} = \frac{6}{6}$. During paralysis of accommodation, V. $= \frac{6}{30}$, $+ 3^{S} = \frac{6}{6}$. Order, $+ 2.50^{S}$ for constant use. In this case the manifest hypermetropia equals 1^{D}, latent equals 2^{D}, and the sum of the two, or total hypermetropia, $= 3^{D}$.

It will be noticed that the full correction (total H.), after the paralysis of accommodation has passed away, will not give perfect vision, or $\frac{6}{6}$, in a patient under forty years of age. The reason is obvious. The hypermetropia is concealed both from patient and physician by contraction

of the ciliary muscle before instillation of the mydriatic, as well as after its effect has passed away. Hence addition of the glass correcting latent H, unless relaxation of the muscle takes place, must decrease acuity of vision by rendering the eye artificially myopic. Persistent wearing of the correcting glasses will eventually cause the latent H. to become manifest, and visual acuity in the distance will thus become normal.

The range of accommodation in hypermetropia is expressed by the equation $a = p + r$, a representing accommodation, p the near point, and r the far point. To the

FIG. 30.



MYOPIC EYE.

lens which equals in focal distance the near point must be added the lens which adapts the eye to parallel instead of converging rays. Thus, if $p = 20$ cm. (5^D), and $+ 2$ is needed to correct total H., Acc. $= 5^D + 2^D = 7^D$.

MYOPIA.

In emmetropia, it will be remembered, the antero-posterior diameter of the globe is of such length that parallel rays of light come to a focus upon the retina, and that in hypermetropia this axis of the ball is shorter, and parallel rays tend to a focus behind the retina. In myopia, the antero-

posterior diameter of the globe is longer than it is in emmetropia, and parallel rays are focused in front of the retina. In the myopic eye, therefore, as in the hypermetropic eye, the retina receives only circles of diffusion, varying in extent with the degree of the myopia. The immediate cause of the longer axis of the myopic eye is found in the too great convexity of the cornea or lens, or both, or in the stretching of the sclerotic coat. Myopia is congenital or acquired, and is usually progressive, that is to say, it has a tendency to increase. It is said to be *low* when the myopia is 3^D or less; *moderate* in the degrees between 3 and 6^D, and *high* in the degrees above 6^D. The *far point* of a myopic eye is the distal limit at which vision equals that of an emmetropic eye, and the *near point* is the approximate limit at which the retina is enabled to distinguish small objects (fine print). The former depends on the degree of the myopia, the latter on the power of accommodation. The distance between the far and near points, is the *range of accommodation*, and is expressed $a = p - r$, because the lens which gives full acuity of V for distance must be subtracted from the lens whose focal length equals the distance of the near point, since the exercise of accommodation can only begin at the far point, which necessarily lies within infinity. Thus, $p = 20$ cm. (5^D), $r = 50$ cm. (2^D), $a = 5 - 2 = 3^D$.

An example of each form of myopia may serve to fix the differences between them more firmly in the student's mind.

Low myopia.—Patient, age twenty, complains of inability to see distant objects clearly. No asthenopia. Has never worn glasses. V. in each eye $= \frac{6}{18}$, $- 2^D$ in trial frame, gives $\frac{6}{6}$. The far point is 50 cm.; near point, 8 cm. Order full correction for distance. No glass for near is required

in the absence of astigmatism, or of heterophoria at the near point, for the patient reads at 33 cm. by the exercise of 1^D of accommodation and 3 meter angles of convergence, and no symptoms will arise from the use of the unaided eyes in near work, unless the relative accommodation is too much disturbed.

Moderate Myopia.—Patient, age twenty, complains of bad vision for distance, headache, pain in eyes, and blurred vision in near work, caused by the necessity of holding the work close to the eyes, which strains the convergence, and this strain quickly induces a divergence through failure of convergence. V., in each eye, $\frac{6}{36}$; $-6.^D$ in trial frame gives $\frac{6}{6}$. Far point, 16 cm.; near point, practically the same. The patient does not require, and, therefore, has never developed, accommodation. The correction ordered is, for far, -5.50^D; for near, -3^D. This correction gives far point at 33 cm., at which distance the patient can comfortably read. For distance, less than the full correction is given, to avoid dizziness and other discomfort from apparent diminution in size of objects.

High Myopia.—Patient, age twenty, vision very bad for distance, and binocular vision for reading impossible. The myopia $= 15^D$. V., in each eye, $= \frac{1}{36}$; $-15^D = \frac{6}{10}$. Full acuity of vision cannot be obtained on account of organic changes in the interior of the eye and the apparent reduction in the size of all objects seen through minus glasses. Order, -12^D for far, and -10^D for near. Accommodation is entirely absent.

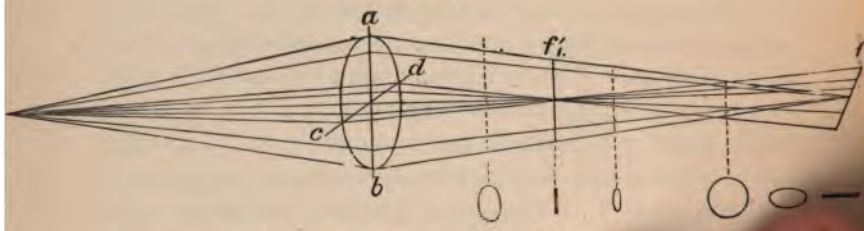
ASTIGMATISM.

ASTIGMATISM is that condition of refraction in which the curve of the cornea or lens or both, is non-spherical, and parallel rays of light entering the pupil are not focused to

a point, but in a line. Astigmatism of the cornea is either *regular* or *irregular; regular* when the two principal meridians are at right angles to each other and have radii of different length, and *irregular* when the corneal curve, as a result of disease, is broken by a number of irregularly defined facets, each one of which has its own radius. Regular astigmatism is hypermetropic, myopic, compound hypermetropic, compound myopic, or mixed.

In *hypermetropic astigmatism* one principal meridian is emmetropic and the other principal meridian at right angles to

FIG. 31.



ACTION OF AN ASTIGMATIC SURFACE ON A CONE OF LIGHT. (F

a, *b*, *c*, *d* is the astigmatic surface; diverging rays proceed from , pas
c d, come to a focus at *f1*, while those passing thr
The outline of the cone of rays *a b*, *c d*, and *f2* var

it is hypermetropic; in *myopi*
emmetropic, and the meri
Compound hypermetro
which both princi
more than the ot
the two princi
other. In
tropic, a
myopi
T

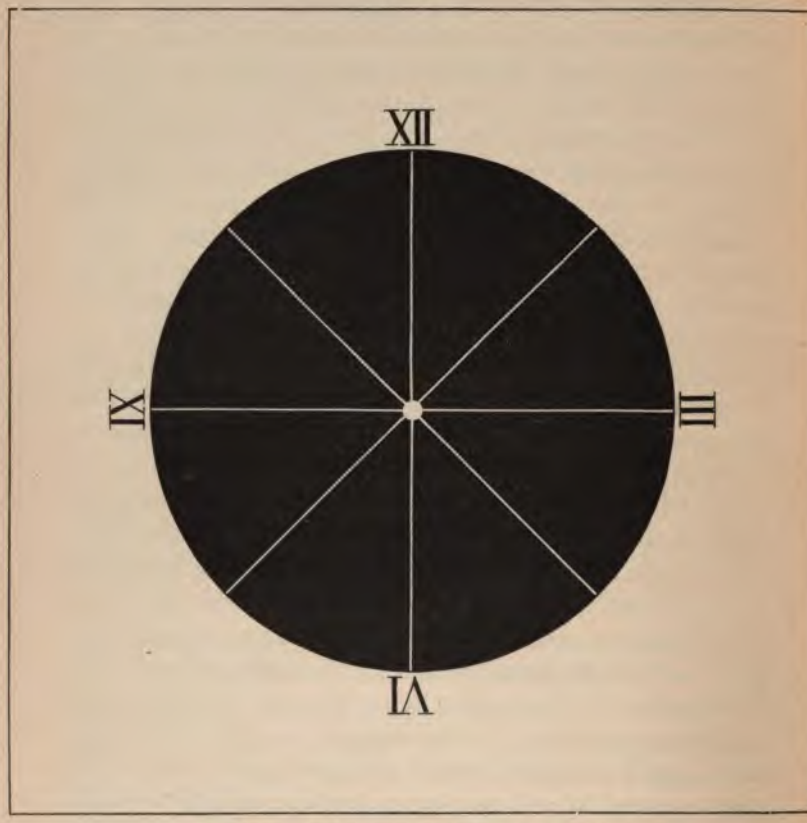
ability to use the eyes in prolonged near work, pain in the eyeballs, headache, and other reflex neuroses, more or less obscure and ill-defined, which distract the patient until the ametropia is relieved by the correcting lens.

Diagnosis and Treatment. An astigmatic test-card,* consisting of exactly similar radiating stripes or lines (Fig. 32), is placed 6 m. from the patient, who is directed to look at them and tell which are the clearest and best seen. One or two of these radiating lines will appear to be brighter and more distinct than the rest. The patient is hypermetropic or myopic for the dull lines. The plus or minus cylinder required in astigmatism to supplement the defective refraction of the hypermetropic meridian, or to diminish the myopic meridian, is placed before the eye with its axis parallel to the faintest lines. When the lines are by this method rendered equally clear, the astigmatism is corrected. In compound hypermetropic or compound myopic astigmatism, the apparent inequality of the lines may be first overcome by a cylinder, and the remaining hypermetropia or myopia corrected by a plus or minus spherical lens, or if the spherical defect is so marked as to prevent recognition of the differences in the lines on the astigmatic test-card, a part or all of such defect may be corrected by a spherical lens, and a cylindrical lens used to correct the remaining astigmatism. In mixed astigmatism the lines will appear to be equally indistinct at 6 m., when the hypermetropic and the myopic meridians are defective to the same degree, but if the astigmatic card is brought nearer the patient, the lines in the myopic meridian will become more clear, and those in the hypermetropic meridian fainter. A minus cylinder will

* The astigmatic card depicted in Fig. 32 was recently made, at our request, by Joseph A. Mullen, and may be obtained from J. L. Borsch & Co., 1324 Walnut Street, Philadelphia.

correct the myopic, and a plus cylinder the hypermetropic, meridian. The two cylinders at right angles to each other

FIG. 32.



ASTIGMATIC CLOCK FOR TESTING ASTIGMATISM.

are converted into a sphero-cylinder, which the patient is instructed to wear. For example, a patient sees horizontal

lines best at 1 m. — 1^{c} ax. 180° gives normal vision for such lines, and + 1^{c} ax. 90° corrects vertical lines at 6 m. The formula is: — 1^{c} ax. 180° ⊖ + 1^{c} ax. 90°, or, and this is the better formula, — 1^{s} ⊖ + 2^{c} ax. 90°.

Following are illustrations of the other forms of astigmatism:—

Hypermetropic Astigmatism: V. = $\frac{6}{9}$, accommodation paralyzed; horizontal lines seen best; + 1^{s} gives vertical lines best without increasing acuity of vision, and —1^{s} makes vision worse; + 1^{c} ax. 90° renders lines equally clear and distinct in all meridians and gives $\frac{6}{6}$.

Myopic Astigmatism: V. = $\frac{6}{9}$, vertical lines are seen best, + 1^{s} increases dimness of lines in all meridians. — 1^{s} improves horizontal and dims vertical lines, —1^{c} ax. 180°, brings out clearly the lines in defective meridians, and gives normal vision, $\frac{6}{6}$.

Compound Hypermetropic Astigmatism: V. = $\frac{6}{12}$, horizontal lines seen best but imperfectly, + 1^{s} improves lines in all meridians, + 2^{s} over-corrects lines on the horizontal axis + 1^{s} ⊖ + 1^{c} ax. 90°, gives the appearance of equality to all lines, and vision is increased to $\frac{6}{6}$.

Compound Myopic Astigmatism: V. = $\frac{6}{18}$; all lines indistinct and acuity of vision too low to discriminate differences in them; — 2^{s} improves all lines, and renders the vertical lines normal in outline and color; — 1^{s} added brings out the horizontal, and dims the vertical lines. Hence a stronger minus glass is required for the horizontal than for the vertical meridian. The formula, — 2^{s} ⊖ — 1^{c} ax. 180° makes all lines appear equal, and gives $\frac{6}{6}$.

Irregular Astigmatism cannot be corrected, but an examination of the refraction will not infrequently reveal an underlying spherical or astigmatic defect, the correction of which will greatly improve vision.

EXAMINATION BY THE OPHTHALMOSCOPE.

The *refraction ophthalmoscope* (Fig. 33) consists of a rectangular or round concave mirror perforated in its centre by a circular opening 4 mm. in diameter. Immediately back of the mirror is one or more metal discs in which is placed a number of lenses, plus 1^D to 20^D and minus 1^D to 20^D, somewhat larger than the opening in the mirror,

FIG. 33.

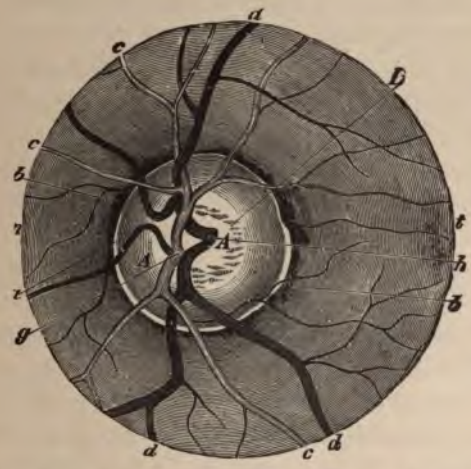
MORTON'S OPHTHALMOSCOPE.

any one of which is made by a simple mechanical device to rotate in position behind the opening.

In the *direct examination* by the ophthalmoscope, the patient is placed about 50 cm. from, and with his back to, the light, which should be drawn to the side of, and on a level with, the eye under observation. To examine the right eye, the observer holds the ophthalmoscope in his

right hand and in front of his right eye. Looking through the opening in the mirror at some little distance from the patient, whose eye is illuminated by reflection of light from the mirror, the observer sees a red reflex through the pupil, the reflection from the choroid of the light thrown by the mirror into the patient's eye. The outlines

FIG. 34.



THE ENTRANCE OF THE OPTIC NERVE WITH THE ADJACENT PARTS OF THE FUNDUS OF THE NORMAL EYE.

A. Physiological excavation. *b*. Choroidal ring. *c*. Arteries. *d*. Veins. *g*. Division of the central artery. *h*. Division of the central vein. *L*. Lamina cribrosa. *t*. Temporal (outer) side. *n*. Nasal (inner) side.

of the majority of the choroidal vessels are concealed by the pigment coat of the retina, and only a glare is seen. Approaching the eye as closely as possible, without changing the refraction of the ophthalmoscope, the vessels of the retina are displayed, leading to and from the optic disc or

papilla (Fig. 34), which appears as a pinkish-white round or oval disc, slightly excavated in its centre. Only a small portion of the fundus can be seen at once, but to the observer, standing in close proximity to the patient, the field covered is apparently large, the details being magnified about fourfold. The principal points to be observed and noted, are the condition of the media, shape of disc, the distinctness of its marginal outlines, character and degree of excavation, pulsation of veins or arteries, presence or absence of pigment spots, calibre of vessels, and disturbances in their coats. The fovea is removed about four times the apparent diameter of the disc to the temporal side of the nerve, and appears as a rounded red spot with a bright, glistening centre, round or oval, and inclined to modify its shape according to the amount, intensity, and direction of the light thrown upon it. The fovea is free from visible blood-vessels. Each part of the fundus should be observed in turn: first, the nerve and adjacent parts, then the fovea, and finally the different quadrants or sections of the fundus. This is readily accomplished by having the patient rotate the eye in different directions. It is good practice in all ophthalmoscopic observations, to examine first the cornea, using $+ 6^{D}$ in ophth. for this purpose, secondly, the pupil and lens with $+ 5^{D}$ and the anterior and posterior portions of the vitreous with $+ 3^{S}$, before proceeding to the details of the fundus.

By the *indirect method* the light is thrown by the mirror through a lens of 13^{D} into the patient's eye. The light, returning through the lens, is focused at approximately its focal distance. Before the opening in the mirror is $+ 4^{D}$, to enlarge the aerial image and to replace the observer's strain of accommodation. This method is

especially useful in determining the condition of the choroid and retina in high myopia and in opacities of the media.

To determine refraction by the ophthalmoscope by the direct method, theoretically, the observer's eye should be emmetropic and at rest, and the accommodation of the eye examined in abeyance. The mirror with the observing eye immediately back of it, is held within half an inch of the eye observed. The media are clear. If observed and observing eyes are emmetropic, rays passing from each point of the fundus of the former become parallel as they emerge out of the cornea, and, entering the cornea of the latter parallel, are focused upon the observer's retina. If the patient is hypermetropic, observer emmetropic, the rays emerging from his cornea are divergent, details indistinct, and a plus glass will be required to so bend the rays that they enter observer's eye parallel, and this is done by rotating the metal disc in the ophthalmoscope until the glass required to clear the picture comes in position behind the mirror. If the patient is myopic, observer emmetropic, the rays emerging out of his cornea are convergent, and a minus glass will be required to render them parallel as they enter the observer's eye. In both instances the observer is aware, by the dim images of the small vessels near the fovea, where only an accurate determination may be made, that the rays from this region are not entering his eye parallel, but from this knowledge alone he cannot tell whether they are converging or diverging. He revolves the disc until he finds a glass which defines the image, and that glass is the measure of the ametropia of the observed eye.

In simple astigmatism the vessels in one meridian will be seen more clearly defined than those of the opposite

meridian, and the spherical lens, plus or minus, which makes those vessels clear and blurs the opposite ones, will designate the degree, kind and axis of the astigmatism. In compound astigmatism, vessels in all meridians are indistinct, some more than others. The glass, plus or minus, which makes each set of vessels in turn clear and distinct, will be the kind and degree of ametropia for these meridians. The disc is usually oblong, its long diameter corresponding with the axis of the astigmatism.

Diagnosis of Hypermetropia by the Ophthalmoscope.—The retinal vessels are seen at several inches from the observed eye, and apparently move in the same direction as the mirror. More details are evident on closer approximation of the ophthalmoscope. The nerve and vessels are distinctly seen without a lens, *but they can also be seen through a convex glass.* The first, by overcoming the divergence of rays emerging from observed eye by contraction of the ciliary muscle in observing eye, and the latter, by relaxation of the contraction, and substitution of a convex glass for it. The disc is apparently smaller than in emmetropia or myopia.

The Diagnosis of Myopia by the Ophthalmoscope.—The disc is large, but ill defined, and can be distinctly seen only through a minus glass and on close approximation. In high degrees of myopia, 8^{D} or more, an aerial inverted image of a small part of the fundus may be seen at a distance of five inches or less. The image is inverted, and vessels, therefore, move in an opposite direction to that of the mirror.

An accurate estimation of the degree of the ametropia is rarely attained, but an approximate estimate is always made by the experienced ophthalmoscopist.

FIG. 35.

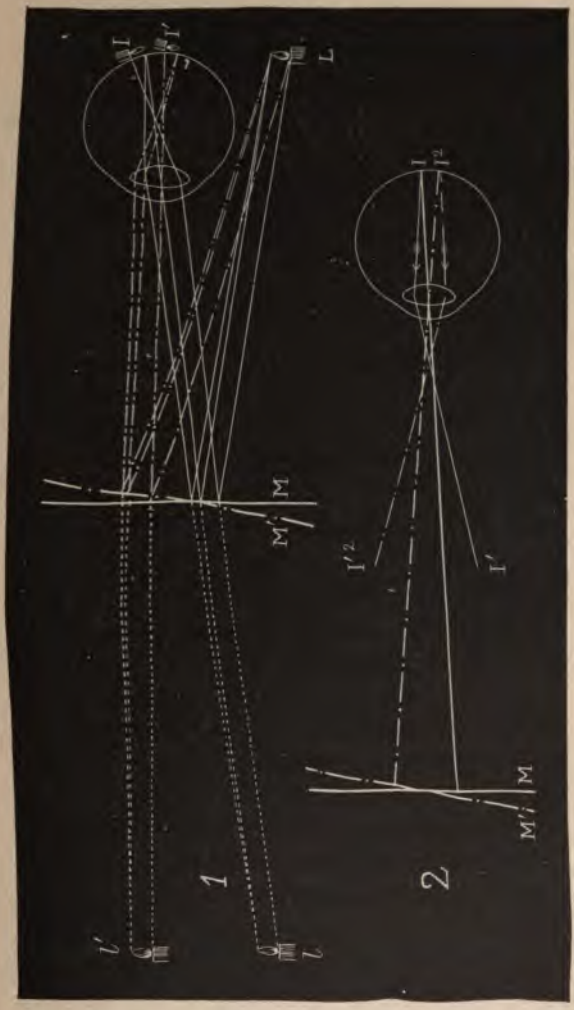


ILLUSTRATION OF RETINOSCOPY BY THE PLANE MIRROR.

1. *L*. Source of illumination. *M*. Mirror. *I*. Inverted image of *L* on retina. *l*. Apparent source of illumination. If the mirror be rotated to *M'*: *I'* New position of *L* on retina. *l'*. New apparent position of *L*. Hence the shadow has moved *with* mirror.
2. Myopic eye, producing an inverted aerial image, since the rays coming out from the eye cross between the cornea and mirror.

RETINOSCOPY BY THE PLANE MIRROR.

The observer stands 1 m. in front of the patient, behind and slightly above whose head a small, bright light is placed. The mirror reflects parallel rays of light into patient's eye, and the rays return out of it parallel (emmetropia), diverging (hypermetropia), or converging (myopia). In an *emmetropic* eye, the image of the flame on patient's retina moves with the movement of the mirror in all meridians. If + 3^{D} is placed in spectacle frame before the patient's eye, the rays emerging out of which are parallel, they will be brought to a point at the focal distance of the lens, 33 cm., the *point of reversal*, as it is called. The point of reversal is determined by the observer, who gradually approaches the patient, rotating the mirror until he notices that the light or shadow in the patient's eye ceases to move against it. No movement of the light is noticed exactly at the point of reversal, but nearer the patient's face, or within the focal distance of the lens, the light will move in the same direction as the movement of the mirror. All meridians of the cornea must be examined, and in each axis the point of reversal will be found at 33 cm. from the patient's eye.

In *hypermetropia*, the shadow moves with the mirror. Use + 3 lens as in the previous case. If the point of reversal is 1 m. from the patient's eye, there must be 2^{D} of hypermetropia. The + 3^{D} corrects all the hypermetropia and produces 1^{D} of artificial myopia, the far point of which is 1 m. (The rays enter the lens diverging from the patient's eye, are brought to a focus at 1 m., hence the + 3^{D} over-corrects the defect by 1^{D}.) If no point of reversal can be determined by + 3^{D} at 1 m., the hypermetropia exceeds 2^{D}, and a stronger lens will be required. Suppose we place + 5^{D} in spectacle

frame, and find that the point of reversal is at 50 cm., which is the far point of 2ᴰ of myopia, the hypermetropia will, in this case, equal 3ᴰ, the + 5ᴰ having over-corrected the defect by 2ᴰ.

In *myopia*, the shadow moves in the opposite direction to *the movements of the* mirror. No lens is necessary unless the defect is less than 1ᴰ. The point of reversal will be found at the far point of the eye, and the distance between this point and the eye equals the refracting power of the excess of curvature in the eye. Thus, if the far point is 40 cm., the myopia equals 2.50ᴰ; if at 33 cm., the myopia equals 3ᴰ, or, if at 25 cm., the myopia equals 4ᴰ. If the far point cannot be found at 25 cm., or farther, and if the shadows continue to move opposite to the mirror at 25 cm., myopia of more than 4ᴰ is assured. Closer than this, an inaccurate estimate of the point of reversal, when the shadows cease to move against, and begin to move with the mirror, causes a considerable error in the result, and to avoid error it is best, under these conditions, to disperse the rays by placing a minus glass in spectacle frame. The lens used for this purpose must be added to the myopia determined by its use. For example, if, with — 3ᴰ held in trial frames the point of reversal is found to be at 50 cm., the myopia = 5ᴰ.

Hypermetropic and Myopic Astigmatism are determined by the method employed in spherical defects, and are not more difficult. The point of reversal is found to be at different distances for the two principal meridians. For example, with + 3ᴰ point of reversal for horizonal meridian is at 1 m., and for vertical meridian 33 cm., the hypermetropic astigmatism is equal to 2ᴰ ax. 90°. Or suppose with + 5ᴰ the point of reversal for horizontal meridian is at 50 cm., H = 3ᴰ ax. 90°, and at 33 cm., for vertical meridian H = 2ᴰ ax. 180°, it must be evident that

there is compound hypermetropic astigmatism, equal to + 2^{s} ⊂ + 1^{c} ax. 90°. If without a lens, the point of reversal for vertical meridian is at 33 cm., the myopia will equal 3^{D} for that meridian. With + 1 the point of reversal for horizontal meridian is at 1 m.; that meridian is emmetropic. Glasses for this case should be,— 3^{c} ax. 180°. Again, suppose that without a glass point of reversal for axis 45° (meridian opposite) = 50 cm. (myopia = 2^{D} ax. 45°), with + 4^{D} in spectacle frames for axis 135° (meridian opposite) = 50 cm. (hypermetropia 2^{D} ax. 135°), the correction will be, — 2^{s} ⊂ + 4^{c} ax. 135°. In conducting examinations by retinoscopy the patient's pupil should be dilated.

This method of determining the refraction is accurate, rapid, scientific, and especially valuable in children and illiterate persons, and in the diagnosis of irregular cornea without opacities.

PRESBYOPIA.

Presbyopia (P) is a failure of accommodation due to senile changes, and is manifested by a recedence of the near point. It is not a disease, it is not an error of refraction, but a loss of elasticity of the crystalline lens, or of power in the ciliary muscle, or the two combined. Greater stress should be laid on the former.

Presbyopia in emmetropia, begins to manifest itself at or about the age of 45 years, the subject noticing that small objects, print, cannot be comfortably or distinctly seen for any length of time at the usual reading distance, 35 cm., and is obliged to hold the book, paper, or sewing farther from the eye than formerly. Continuous reading induces blurring, pain, headache, lacrymation, etc. A glass which will bring the near point closer to the eye, and thus diminish

the effort to focus small objects at 35 cm., in which there is an obligation to call too much on the reserve accommodation, is required. About the age of 45 years, the near point = 20 cm., the reading distance 33 cm., and the reserve accommodation = 2^{D}. At this age, therefore, an emmetropic person must exercise in near work all but 2^{D} of accommodation. With + 1^{D}, the near point is brought back to 16 cm., and he thus has for 33 cm., 3^{D} of accommodation in reserve. At 50 years the near point has receded to 25 cm., and the total accommodation equals 4^{D}, and + 2^{D} brings near point to 16 cm. and patient reads comfortably at 33 cm. with 3^{D} of accommodation in reserve. At a more advanced age, accommodation has entirely failed and must be substituted by a plus glass which has a focus at a convenient distance for close work. Patients differ in showing signs of advancing age, and no law governing increase of glass can be laid down as unalterable, but the above changes represent the average of cases, and must be modified to meet individual necessities.

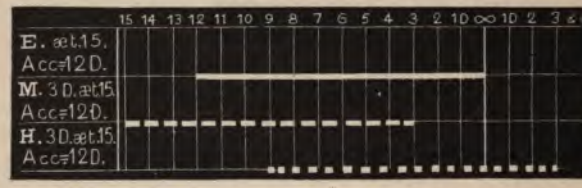
Presbyopia in hypermetropia and in compound hypermetropic astigmatism. The convex lens necessary to restore the receded near point, must be determined exactly as in emmetropia, and added to the correction of existing hypermetropia or compound hypermetropic astigmatism. For example, + 2^{D} = $\frac{6}{6}$ in a patient, age 50, near point (with + 2^{D}) = 25 cm. By adding + 1.50^{D}, the near point = 18 cm.; + 2^{D} is ordered for distance, and + 3.50 for near. Another case: Patient, age 45, + 1^{S} ⊖ + 2^{C} ax. 90° = $\frac{6}{6}$, which is ordered for distance, and + 2 ⊖ + 2^{C} ax. 90° for near.

Presbyopia in Myopia, and Compound Myopic Astigmatism. The presbyopic correction in higher grades of myopia must be made at a much earlier age than in emmetropia or

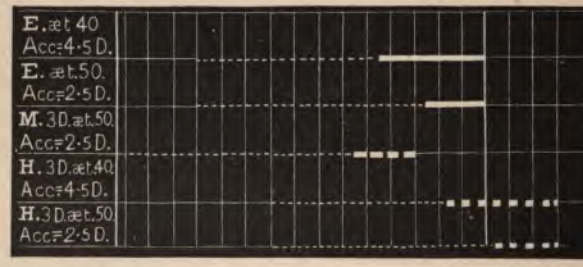
hypermetropia, on account of the natural feebleness from non-development of the ciliary muscle. Example: $-2^{D} = \frac{6}{6}$. No glass will be required for near work until patient has reached forty-five to fifty years, because he has used but 1^{D} of accommodation for reading at 33 cm. After that age plus glasses must be added, accommodation having

FIG. 36.

A.



B.



DIAGRAMS OF RANGE OF ACCOMMODATION IN E., H. AND M.
A. Patient aged 15. B. From 40 to 50 years.

commenced to fail. At sixty, -2^{D} for far, and $+1.50^{D}$ for near vision. Patient, age forty-five, requiring $-8 \bigcirc -2^{C}$ ax. 180° for distance, will wear $-5 \bigcirc -2^{C}$ ax. 180° for near. Take, as an example, next, simple myopic astigmatism: -2^{C} ax. 135° $= \frac{6}{6}$, in a patient forty-five years old,

the presbyopic correction is + 1 ⊂ — 2^{c} ax. 135°. At the age of fifty, the correction would be + 2 ⊂ — 2.^{c} ax. 135° (= + 2^{c} ax. 45°).

Presbyopia in mixed astigmatism: age forty-five, —1 ⊂ + 3^{c} ax. 90° = $\frac{2}{3}$. Add + 1. for near, which would give as the presbyopic correction + 3^{c} ax. 90° (+ 1 added to — 1 = 0); at fifty, add + 2^{p} for near, which would equal + 1 ⊂ + 3^{c} ax. 90°.

In all cases of presbyopia the weakest glass which will serve all the purposes demanded should be ordered, for it must be remembered that the ciliary muscle and internal rectus are supplied by the same nerve, and that a strong glass enforces excessive convergence.

MYDRIATICS.

In estimating total hypermetropia or hypermetropic astigmatism, and especially those of minor degree, it will be necessary to paralyze the accommodation in most persons under forty years of age. After that age the accommodation is so limited that it may be dispensed with as an important factor in the correction of ametropia. Contra-indication to the use of a mydriatic in a patient more than forty years of age, is based on the fact that its employment may precipitate an attack of acute glaucoma in an eye predisposed to that disease. In persons less than forty years old, this disease is rarely encountered. Moreover, after that time of life the accommodation has become relaxed to such an extent that paralysis is not only unnecessary but a positive hindrance, since it is desirable in most cases of this nature to estimate the range of accommodation and prescribe glasses for near work, and this cannot be accurately done during paralysis.

In low degrees of myopia and myopic astigmatism in young persons, abolition of the accommodation is necessary, because contraction of the ciliary muscle increases the defect, and a glass ordered without mydriasis would over-correct the error.

Spasm of Accommodation, which is frequently present in low degrees of hypermetropia or hypermetropic astigmatism, simulating myopia, cannot be corrected without mydriasis. The patient should be informed that vision will be temporarily disturbed by the mydriatic, and that near work will not be possible during the continuance of its action. The patient should also be told of the possible constitutional effects, such as flushing of the face, dry throat, dizziness, drowsiness, and, in rare instances, active delirium.

Mydriatics are sometimes very useful in discriminating nervous symptoms due to eye strain, headache, chorea, and other reflex disturbances of function, from those due to other causes. During paralysis of accommodation, should they be due to overaction of the ciliary, or extrinsic ocular muscles, they will be modified or entirely subdued, to return when the mydriasis has passed away. When the symptoms are due to organic lesions, or disease of other organs, they are not affected by paralysis of accommodation.

Atropine sulphate (gr. iv–℥j), duboisine sulphate (gr. ij –℥j), hyoscyamine sulphate (gr. ij–℥j), and hydrobromate of homatropine (gr. viij–℥j), are the mydriatics employed for the purposes thus indicated, as well as in certain inflammatory conditions of the eye to secure rest of the organ, and to prevent adhesions between the iris and lens capsule, or between the iris and cornea.

For determining refraction, duboisine is to be preferred to

other members of the group. It acts more rapidly, and the effects pass away sooner, than atropine; and as compared with hyoscyamine and homatropine, the mydriasis is more complete, when induced by one or two instillations of the drug. Atropine is indicated in disease. To dilate the pupil for the purpose of examining the eye ground homatropine is probably the best agent, its action being rapid and transient.

The hydrobromate of cocaine (4 per cent. sol.) dilates the pupil and partly paralyzes the accommodation, and should, therefore, be classed among the mydriatics. It is, however, useless as a mydriatic, because it destroys the epithelium of the cornea and clouds its transparency. In ophthalmic practice it is only used to induce local anæsthesia, or as an adjunct to other mydriatics to secure the widest possible dilatation of the pupil.

PART IV.

THE OCULAR MUSCLES.

The action of the muscles upon the eyeball should be considered, first, in respect of the change of position of the cornea; and, secondly, of the change of position of the vertical meridian of the cornea.

The external rectus rolls the cornea outward, the internal rectus inward, the superior rectus upward and inward, the upper end of the meridian turning inward, and the inferior rectus rolls the cornea downward and inward, turning the upper end of the meridian outward. The superior oblique muscle rolls the cornea downward and outward, turning the upper end of the meridian inward, and the inferior oblique rolls it upward and outward, rotating the upper end of the meridian outward.

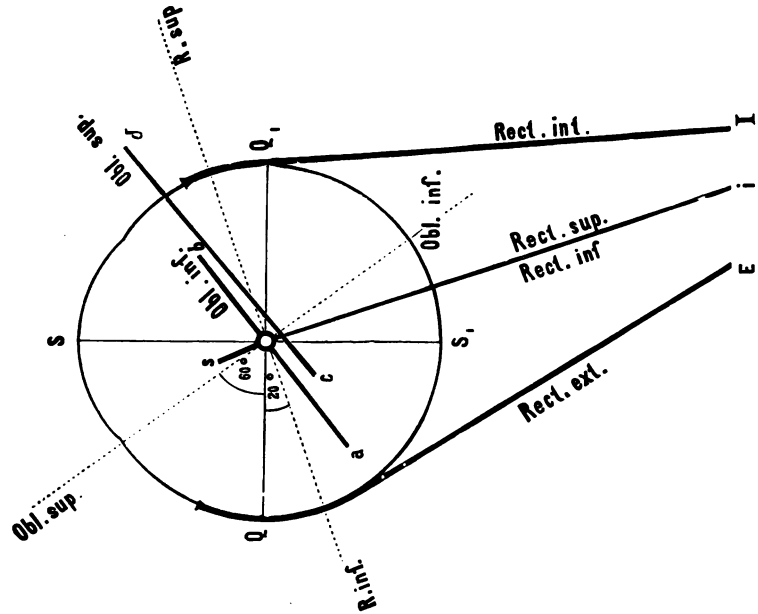
The globe is rolled *outward* by the combined action of the external rectus and the two oblique muscles; *inward* by the internal, superior, and inferior recti; *upward* by the superior rectus and inferior oblique, and *downward* by the inferior rectus and superior oblique. (Fig. 37). The muscular apparatus of the two eyes are in intimate association, have a concerted action, and are stimulated by a common nervous impulse.

PARALYSIS.

In paralysis of an ocular muscle, the symptoms are marked and significant. There is double vision (diplopia) with limited movement of affected eye on the side and in the

direction of the paralyzed muscle, and secondary squint, or corresponding deviation of the sound eye, when fixing with the affected eye. The head is disposed toward the paralyzed side, and the eye has a tendency to close. Dizziness, confusion, and incorrect estimation of position and of space,

FIG. 37.



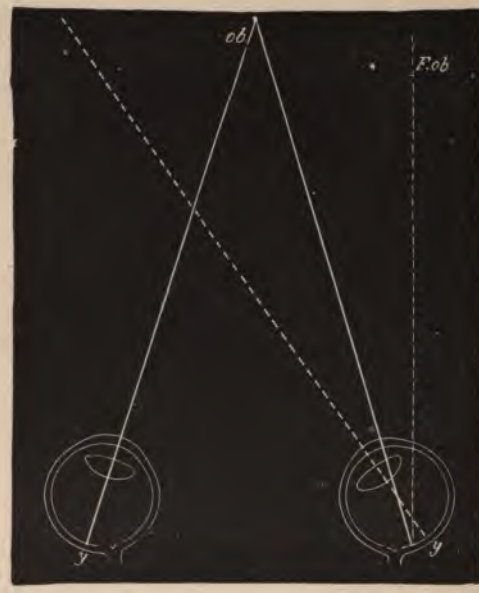
SCHEME OF THE ACTION OF THE OCULAR MUSCLES.

Q E. Direction of traction of ext. rect. Q_1, I. Of int. rect. S i. Of sup. and inf. recti. *a b*. Of inf. oblique. *c d*. Of sup. oblique. O. Point of rotation. Q Q_1. Transverse axis.

are occasional symptoms. The two images of a single object seen in the median line are more widely separated when the object is moved in the direction of the action of the paralyzed muscle. The *true* image is seen by the sound,

and the *false* image by the affected, eye. To determine the eye and muscle affected, the position of the images and the changing relation between them, induced by the movement of head and object looked at, must be studied. It may be stated in general terms that, first, the image is false, and belongs to the affected eye, which, in the region of

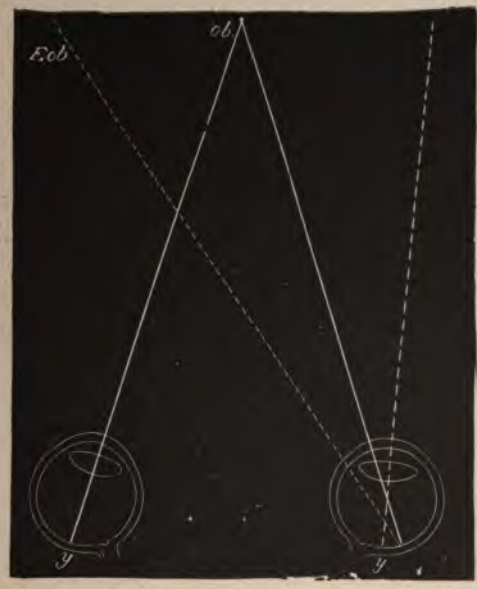
FIG. 38.



diplopia, moves faster than the moving object; second, that in pathological convergence homonymous (image on same side as the eye), and in pathological divergence, heteronymous (image on side opposite to eye), diplopia is found; and, third, the false image stands in such relation to the affected eye as the paralyzed muscle normally functionates.

In paralysis of the *external rectus* (Fig. 38) the diplopia is homonymous (not crossed), and the images are not tilted at either end. In paralysis of the *internal rectus* (Fig. 39) the diplopia is, conversely, heteronymous (crossed), and the false image is not tilted at either extremity. The diplopia is crossed opposite the affected muscle in paralysis of the

FIG. 39.



ob. Object. *Fob*. Apparent position of object seen by right eye.

superior rectus, and the upper end of the *false* image is tilted slightly inward. The diplopia is also crossed in paralysis of the *inferior rectus*, the upper end of the *false* image tilting slightly outward. There is homonymous diplopia in paralysis of the superior and inferior oblique;

in the former case the upper end of the false image is tilted inward, and in the latter outward.

The position of the images is modified when more than one muscle is paralyzed, and the diagnosis is, under these conditions, not infrequently obscure.

OPHTHALMOPLEGIA is the name given to designate paralysis of all the muscles of the eye. Ophthalmoplegia externa is an occasional symptom of locomotor ataxia. Ophthalmoplegia interna is very rare, but paralysis of accommodation, or partial ophthalmoplegia interna, is a common sequence of diphtheria.

The affection may be caused by syphilis, rheumatism, traumatism, tumors, hydrocephalus, diphtheria, meningitis, spinal affections, and by basal, cortical, or nuclear disease.

Prognosis is good in syphilis, rheumatism, and diphtheria, and grave in organic disease of the brain, nerve, or spinal cord.

Treatment is medical or electrical, and is primarily addressed to the cause of paralysis. Operative interference is not warranted.

NYSTAGMUS is an involuntary oscillation of the eyeball, due to the instantaneous contraction and relaxation of one or more muscles from defective co-ordination. It is congenital in microphthalmus, coloboma, certain forms of congenital cataract, albinos, and in Friederich's disease. It is present, sometimes, in lesions of transparency due to ophthalmia neonatorum, and in retinitis pigmentosa. Miners who are compelled to work for long periods of time in strained positions, and in darkness, frequently develop the disease. Internal squint is a frequent complication of nystagmus.

The prognosis is never encouraging under the most favorable circumstances, but the vision, which is usually

defective, may be improved by glasses, the squint cured by operation, and some relief from the more distressing symptoms obtained by these means in cases of recent duration. No further relief has been hitherto accomplished.

FUNCTIONAL MUSCULAR AFFECTIONS.

In muscular anomalies of a functional character, there is a deviation, or a tendency to deviation, of the eyes from equilibrium.

Accepting Stephens' nomenclature, which is accurately descriptive and scientific, the different muscular anomalies are defined as follows:—*Orthophoria*, perfect binocular equilibrium; *Heterophoria*, imperfect binocular equilibrium; *Hyperphoria*, a tendency of one eye to deviate upward; *Esophoria*, a tendency to deviate inward; *Exophoria*, a tendency to deviate outward; *Hyperesophoria*, a tendency to deviate upward and inward of one eye, or downward and inward of the other; *Hyperexophoria*, a tendency to deviate upward and outward of one, or downward and outward of the other, eye.

It must be borne in mind that functional deviations involve both eyes. One eye alone cannot be at fault in convergence. In hyperphoria, one eye may have a tendency upward, or the other eye downward, and these relations may be interchangeable. The term, therefore, does not indicate where the fault lies. For instance, right hyperphoria means that the superior rectus of the right eye is too strong for the inferior rectus of the same eye, or that the inferior rectus of the left eye is too strong for its superior rectus. Right hyperphoria means, then, that the right eye has a tendency to turn higher than the left.

Orthotropia is a term used to express perfect binocular

fixation; *Heterotropia*, a *turning* from parallelism; *Esotropia*, a turning inward, convergent squint; *Exotropia*, a turning outward, divergent squint; *Hypertropia*, a turning upward; *Hyperesotropia*, a turning of one eye upward and inward, and *Hyperexotropia*, a turning of one eye upward and outward.

The strength of an ocular muscle is measured by its ability to overcome prisms, while both eyes are fixed on a small light at 6 m. The external recti, abduction, overcome in the average 8°, and the internal recti, adduction, 30°. The superior rectus of one and the inferior rectus of the other eye (sursumduction) overcome, on the average, 3°. This power to overcome prisms may be greatly increased by exercise.

The procedure is not difficult. Place a small light 6 m. away and instruct the patient to look steadily at the flame with both eyes. To measure the strength of the internal recti, adduction, place a prism of 10° with the angle *in* before the right eye. The image of the flame is thrown to the right of the fovea, and double images are momentarily seen until the internal rectus contracts, and thus rotates the eye inward till the fovea reaches the site of the image and there is fusion of the images. Another prism of 10° introduced before the left eye, angle in, throws the image to the left of the fovea; the internal rectus contracts to the same extent, and again single images are seen. This procedure is carried on until the internal recti can no longer fuse the images. The highest prism through which single images can be seen is the measure of adduction. While overcoming prisms of increasing strength, the eyes are seen to become more and more turned inward. To measure the strength of the *external recti*, abduction, prisms of increasing strength with their angles *outward*, are placed

before the eyes, until about 7° are used. In order to overcome the double images one eye is deflected strongly *outward*, that is to say, the external rectus of that eye is contracted.

The angle of the prism is placed in the direction of the action of the muscle to be tested.

In low degrees of heterophoria, the diagnosis depends on the induction of artificial diplopia, and on establishing the relation to each other of the two images thus induced at infinity, and at the reading distance. In testing for hyperphoria, lateral diplopia must be produced by a prism strong enough to overcome either the external or internal rectus. As the external recti at 6 m. are the weaker muscles, a prism of 4°, held horizontally a few inches in front of each eye, with its angle outward, may be used. In orthophoria, the images of the candle flame at 6 m. will be side by side in the horizontal plane. In hyperphoria the images will be lateral, but one higher than the other. For example, in left hyperphoria, the left eye is released by the prism of 8°, which the external recti cannot overcome, from the necessity of maintaining binocular vision, and, yielding to its abnormal disposition to deflect from parallelism, turns upward. Hence its image will be lower than the image of the right eye. The prism required to restore it to the plane of the image of the right eye, with its angle upward, will be the angular measurement of its displacement, and the left hyperphoria will equal that number in prismatic degrees.

In testing equilibrium of the lateral muscles a prism, strong enough to overcome the action of the superior or inferior rectus, will give vertical diplopia. If the lateral muscles are in equilibrium, the images will be in a vertical plane. In esophoria, the candle flame at 6 m., seen by the

right eye, will be to the right of the vertical plane passing through the image seen by the left eye, homonymous diplopia; and in exophoria the image seen by the right eye will be to the left, crossed diplopia, and the prism, base out in esophoria and base in in exophoria, which restores the image seen by the right, into the vertical plane of the left, will be the angular measurement of the deviation.

For the reading distance, 35 cm., the tests are conducted in precisely the same way, but the object for fixation should be the size of letters ordinarily read at that distance.

Esophoria is usually greatest in the distance, and exophoria at the near point.* Hyperphoria is the same at all distances. In many cases of heterophoria it cannot be determined which eye is at fault. We are sometimes aided in diagnosis by information supplied by the patient as to which image, during artificial diplopia, wanders from equilibrium, which seems to the patient to be the true and which the false, and by the condition of the refraction. If a refraction error exists, and is greater in one eye than in the other, or if the acuity of vision differs in the two eyes, the affected muscle may be ascribed to the weaker eye.

As has just been intimated, heterophoria is influenced by refraction. Hypermetropia and hypermetropic astigmatism cause esophoria in a very considerable proportion of cases, and are found associated with it. Although exophoria cannot be said to depend on refraction error, it is frequently associated with myopia and myopic astigmatism. Hyperphoria seems to be largely independent of ametropia.

The local symptoms are those of accommodative strain, and are of little value in the diagnosis. The reflex symptoms are at times severe—headache, nausea and vomiting,

* In testing muscles, ametropic and presbyopic corrections should be worn.

indigestion, choreic movements, and the various vague and misleading phenomena of nervous prostration. On the other hand, they may be slight or altogether wanting.

The diagnosis of heterophoria is not difficult, although its detection may require patient and skillful manipulation. Double vision may never have been noticed by the patient, but can be often produced by covering one eye with a red glass while the patient looks at a small flame at 6 m. With a little perseverance, the patient will acknowledge seeing the two lights, one natural in color the other red, and by the relations they bear to one another, the kind and degree of heterophoria may be determined. And this is true whether the squint is high or low. Even in cases of long-continued internal or external strabismus, where the patient has ceased to have double images by the unconscious suppression of one, its existence may be thus recognized; and when the patient is convinced that he really sees two lights, the diagnosis is simple. In treatment it is important that the patient shall acknowledge the two lights, for the surgeon is guided during his operation by the new position of the images.

Maddox has suggested the use of a glass rod, instead of prisms, in the determination of heterophoria. A glass rod is a strong cylinder which distorts the natural flame into a long streak of light. The difference between the image seen by the eye before which the glass rod is placed and that seen by the other eye, is so marked that binocular fixation is not possible in the absence of muscular equilibrium. If, for instance, the rod is placed before the right eye in an exactly vertical position, the streak of light will be horizontal, and in orthophoria the light will be seen directly in the centre of the streak. In hyperphoria the light will be above or below the streak. In esophoria it will be to the left, and in exophoria to the right of the

streak. The light will be restored to its proper position in heterophoria by a prism of necessary degree with its angle in the direction indicated by the existing conditions; or in testing for esophoria or exophoria, the rod may be held horizontally, and the streak of light thus rendered vertical. It will then be necessary for the patient to determine whether the streak is to the right or left of the light.*

Treatment.—In every instance, the refraction should be examined, and ametropia corrected. This procedure alone will in some cases, and particularly in esophoria, be found sufficient to modify the defect or even restore the muscles to a condition of equilibrium. No arbitrary rules can be laid down for the treatment of the muscular anomaly itself. It is a functional affection, subject to variations in the degree of the defect, as well as in the severity of its symptoms. In general, experience teaches that (1) prisms should be tried; (2) that the degree to be worn shall approach as nearly as practicable the total degree of insufficiency; (3) that they should be constantly worn, excepting in exophoria for near, where there is orthophoria for distance; (4) that prisms should be worn long enough to allow the muscles time to spontaneously regain their equilibrium; (5) that prisms may develop *latent* heterophoria. If the correction of the ametropia and the wearing of prisms prove ineffectual, tenotomy must be performed.

HETEROTROPIA.

STRABISMUS or SQUINT.—Heterotropia is a deviation of the visual axis of one eye from that of the other in the act of vision, the result of muscular overaction, or of muscular

* It is essential in the diagnosis of muscular anomalies, that the patient's head shall be held erect, inclining to neither side.

weakness. Ordinarily, the squint is of such degree that simple inspection is sufficient to designate the eye affected. When the patient fixes an object indifferently with either eye, the squint is *alternating*. If the same eye always deviates, the strabismus is *mono-lateral, or constant.* To determine the character of the deviation more accurately, the patient is directed to look at a small flame at 6 m. with each eye alternately, the other being covered with a card, and if no deviation of the eye behind the card is present there is binocular vision for that distance. The light is now brought within 50 cm. of the eye and the preceding test repeated. If again there is no deviation, the squint is only apparent, and due to a large angle α in hypermetropia, or to a small angle α in myopia. If one eye suddenly deviates, the condition is termed *concomitant* strabismus. If the sound eye turns from fixation, when covered, the movement is termed secondary deviation. In differentiating paralysis of an ocular muscle from functional squint, the action of the muscle in the former is intermittent and limited, and the secondary is always greater than the primary squint. The image of the squinting eye is after a time unconsciously suppressed, and the most scientific method of determining the character and degree of the deviation, is to compel recognition of the double images which are invariably present. To accomplish this end, repeated examinations with colored glasses adjusted before the eyes, and the exercise of a considerable amount of patient manipulation, are necessary. A deep-blue or red glass, held before the fixing eye, so subdues its image that the patient will more readily recognize the false and brighter image seen by the deflected eye. It is not infrequently found by this method that the *false* is not on a horizontal plane with the *true* image, but lies above or below the plane in this meridian,

demonstrating the involvement of other as well as the lateral muscles.

INTERNAL STRABISMUS, ESOTROPIA, is the deviation inward of one eye, and is in four-fifths of all cases, caused by, and associated with, hypermetropia. It will be remembered, in explanation of this statement, that the hypermetrope attains visual acuity only by the exercise of an abnormal amount of accommodation, involving a corresponding stimulation of the internal recti muscles (convergence). If convergence equal accommodation, the visual axes would cross in close proximity to the eyes, and all objects beyond this point of crossing would appear double. In order to maintain single and moderately clear vision, the patient learns to unconsciously throw all stimulation into the internal rectus muscle belonging to the eye which, by reason of its higher optical defect, or impaired vision from other causes, is more or less strongly converged. Images are on the same side (homonymous diplopia).

Strabismus due to hypermetropia is likely to manifest itself at an age when small objects, letters of the alphabet, etc., are first noticed. Moderate degrees of hypermetropia, two to four diopters, may be overcome, and good acuity of vision obtained, by accommodation at the expense of convergence, but in higher degrees, the accommodation is not strong enough to overcome the error of refraction for any length of time and, in consequence, the internal recti muscles do not receive abnormal impulse. Hence internal squint is rare in high hypermetropia. *Amblyopia* of the squinting eye is common, but whether the imperfect vision is due to the squint, or the squint to the imperfect vision, is a question yet undecided.

In all cases, the error of refraction (hypermetropia) should be corrected, and in a certain proportion, where the strabis-

mus is of moderate degree and not of long standing, the eyes may be brought into equilibrium by lenses which remove the strain on the accommodation; when, however, binocular vision is not obtained by this means, the internal recti should be divided. The performance of this operation is followed by relief of the deformity, but does not materially improve the vision of the squinting eye.

EXTERNAL STRABISMUS, EXOTROPIA, is an outward deviation of the visual axis of one eye from fixation, frequently dependent on and associated with myopia. It is caused, not by over-action of the external recti muscles, but from a weakness of convergence, consequent upon the abolition of the necessity for accommodation, due to the increased convexity of the ball in myopia. It is occasionally found in eyes not myopic, and is then due to insufficient action of the internal recti muscles, or to acquired monocular blindness. The images in divergent strabismus are crossed (heteronymous diplopia).

Before the eye becomes permanently deflected, correction of the myopia which necessitates the use of a normal amount of accommodation for near objects, and hence for convergence, will be sufficient to effect a cure, aided by the exercise of the internal recti in overcoming prisms with their bases out, the patient gazing at a bright object 6 m. removed. Tenotomy of the external recti alone, or in conjunction with advancement of the tendons of one or both internal recti muscles will, in most cases, be necessary.

Functional squint upward, or downward, is seldom manifested otherwise than as complications of internal and external strabismus.

PART V.

DISEASES OF THE CONJUNCTIVA.

CONJUNCTIVITIS.

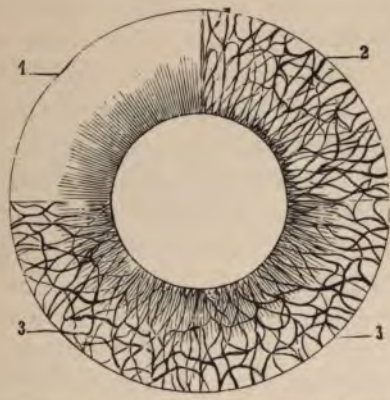
The terminal branches of the transverse facial, facial, middle temporal, lacrymal, infraorbital, supraorbital, palpebral, frontal, nasal and muscular arteries, ramify loosely over the sclera through the subconjunctival mucous membrane, and are injected in the different forms of conjunctivitis. They are not normally visible, but when the tissues supplied by them are irritated or inflamed, they are visibly congested, tortuous and movable, their calibre gradually diminishing as they approach the corneal border. In the palpebral conjunctiva, the individual vessels are not always seen, but a diffuse and deep-seated redness is imparted to the entire surface during the continuance of an inflammatory process. In all forms of conjunctival inflammation, the discharge, an invariable symptom, is contagious.

Hyperæmia.—Hyperæmia of the conjunctiva may be acute or chronic. In either case, it is characterized by injection of the ocular and palpebral vessels, and by a localized or diffused swelling, chemosis, œdema, or hypertrophy of the mucous follicles or papillæ. The cause of the hyperæmia will usually be found to be due to the lodgment in the conjunctiva of a small foreign body, to lacrymal obstruction, ametropia, or to inverted ciliæ. The patient will complain of dryness, burning and itching of the affected lids, and of lacrymation. These symptoms are relieved,

and the patient cured in a few days, by bathing the affected eye with cold water, followed by mild astringent washes. A solution of cocaine hydrochlorate (2 per cent.), dropped into the conjunctival sac every two or three hours, will give temporary and welcome relief.

ACUTE CATARRHAL CONJUNCTIVITIS.—In acute catarrhal conjunctivitis, the redness and other symptoms noticed in hyperæmia are more aggravated and pronounced, and, in

FIG. 40.



CONJUNCTIVAL AND SUBCONJUNCTIVAL INJECTION.
1. Pericorneal zone. 2. Conjunctival injection. 3, 3. Sclerotic injection.

addition to them, there is a discharge of mucus or muco-pus from the inflamed surface. During closure of the lids in sleep, the discharge collects and dries on their free margins, gluing them together. There is also pain, photophobia, and inability to use the eyes in prolonged, close work. It is a universally common affection, occurs idiopathically and in epidemic form, "pink-eye," and may arise from the causes which induce hyperæmia, from inflammation of contiguous

membranes, or from contagion. Treatment consists in removal of the cause, in the local application of astringent lotions, and in marginal inunctions to prevent gluing. The patient is directed to bathe the eyes frequently through the day with the following effective lotion :—

℞. Sodii biboratis, ... gr xx
Aquæ camphoræ,
Aquæ destillat, ... āā . . . . . ℥ij,

and to rub Pagenstecher's ointment,—

℞. Hydr. oxidi flavi, ... gr j
Ungt. petrolei, ... ℥j,

along the margin of the lids on going to bed at night. Hydrochlorate of cocaine (gr. ij–℥j) may be added to the lotion if there are special indications for its employment.

Chronic Catarrhal Conjunctivitis is due to the long continuance of one or more of the causes noticed in the etiology of the acute form, to which might be added smoky or dusty atmosphere, and poor hygienic surroundings. In the chronic form of the disease it may be necessary, in addition to the treatment already given, to frequently apply to the everted conjunctiva of the lids, the nitrate of silver in solution (grs. ij–℥j), copper sulphate (gr. j–℥j), or a solution of tannic acid in glycerine.* A severe case is usually followed by blepharitis marginalis or angularis, dermatitis angularis, eversion of lower punctum with epiphora, and by keratitis.

The use of caustics is contraindicated in anæmia of the

---

* ℞. Tannic Acid, ... ℥j
Glycerine, ... ℥j.
M. S.—Apply to everted lids every other day.

conjunctiva, or while the exudation is thin and sanious, and indicated in high degrees of conjunctival injection when the discharge is excessive, thick and purulent. The strength of the solution, and the intervals between applications, depend on the amount and purulency of the discharge. Its strength should be lessened as the inflammation diminishes.

VERNAL CATARRH is characterized by hypertrophy of the conjunctival epithelium, deposition of inflammatory exudation at the corneo-scleral margin, vascular fullness, and by peripheral opacity of the cornea. The ocular conjunctiva is but slightly injected, while the palpebral conjunctiva is, on the other hand, thickened, smooth, and pallid. The affection is binocular, affecting children and young adults, appears in the spring of the year, attains a maximum of severity in a few weeks, and continues, practically uninfluenced by treatment, with slight exacerbations and remissions, until frost, when it slowly disappears. Its average duration is four years. The symptoms are those of chronic catarrhal conjunctivitis.

FOLLICULAR CONJUNCTIVITIS is characterized by the development, immediately under the palpebral epithelium, of small, round and prominent, pale-red follicles, consisting of lymph deposits, arranged in parallel rows. These deposits are more marked and numerous near the fornix in the lower lid. When the inflammation has subsided, they disappear, leaving no cicatrix in the conjunctiva. The disease is acute or chronic. In the former case, the inflammation is severe, the hyperæmia intense, and there is, in the region of the fornix, a marked infiltration of the tissues, with pericorneal injection. The secretion is thin and abundant. In four or five days after the onslaught of the disease, follicles appear in both lids. In the chronic

form, the signs of inflammation are not marked, and the follicles are limited to the lower lids.

Follicular conjunctivitis is induced by contagion, prolonged local medication, such as applications of nitrate of silver, instillation of atropine, etc., and by unhygienic surroundings. The disease may last for weeks or months, but the prognosis is favorable. The cause should be ascertained and removed, and remedies employed to subdue the

FIG. 41.

GRANULAR CONJUNCTIVITIS.

inflammation and *indirectly* remove the follicles. Treatment is not primarily directed toward the eradication of the follicles.

GRANULAR CONJUNCTIVITIS, OR TRACHOMA, consists of deposition in the stroma of the conjunctiva of small masses of lymphoid cells (Fig. 41), most marked in the upper lid. These cells are nourished by newly formed blood-vessels, and gradually undergo transformation into connective tissue elements. The process is a true hyperplasia, always

attended by severe inflammation, and eventuates in permanent tissue changes in the conjunctiva and cartilage. The granulations, which first develop in the upper lid, are numerous, adjacent to one another, and, spreading over the surface until the entire lid is involved, present the characteristic appearance of minute bunches of grapes, of a deep red color. The granulations are smaller and less thickly spread over the surface of the lower lid. Through an extension of the inflammatory process, the ocular conjunctiva and cornea are eventually involved.

The inflammation is of a high grade in the acute form of the disease, develops rapidly, and, if checked before merging into the chronic form, is not attended by permanent consequences of a serious character. The chronic form, which is most frequently seen in hospital practice, is divided into *three* stages.

In the first stage, *the stage of development*, the injection of the conjunctival vessels may be moderate or intense, and there is either a gradual or rapid infiltration of the conjunctiva of the upper lid. In the former case, the development of granulations is slow; in the latter, numerous and large granulations quickly appear on the conjunctiva of the upper lid, accompanied by a constant and profuse discharge, the *acute* thus passing into the *chronic* form. In the second stage, or *stage of acme*, the conjunctiva of the upper lid is transformed, its proper epithelium destroyed, old blood vessels enlarged, new ones formed, and granulation cells deposited in its stroma Owing to these changes, the conjunctival surface is irregularly roughened by elevations and depressions. The conjunctiva of the lower lid undergoes similar alterations in a less degree. The ocular conjunctiva, particularly the upper section, is hyperæmic and the seat of granulations. The scleral and episcleral

veins are distended. Even the cornea is invaded, usually in its upper half. It becomes vascular, opaque, and denuded of epithelium, which is destroyed either by extension of the peculiar granular inflammation into its stroma by continuity, or by friction of the roughened upper lid. The keratitis thus produced is a superficial vascular inflammation, *pannus* (Fig. 42). In the third stage, or stage of *cicatrization*, the granulations have disappeared and the conjunctival surface has lost its roughness. The membrane is, however, shrunken and streaked with one or more hori-

FIG. 42.

PANNUS AFFECTING UPPER HALF OF CORNEA.

zontal white lines, marking its close anatomical connection with the underlying cartilage, which is curved with its convexity outward (entropion). The lids droop, the ciliæ are irregular (distichiasis), or turned inward against the cornea. The palpebral space is narrowed by atrophy of the conjunctiva in its entirety. The cornea is partly opaque, and is traversed by a few tortuous vessels. The lower lid undergoes changes and malformations of the same character, but in less degee.

The symptoms are, in the first stage, pain, burning, and

itching of the lids, discharge of pus or muco-pus, lacrymation, photophobia, and inability to use the eyes. In the second stage, dimness of vision is added to the above symptoms, and, in the third stage, there is a partial loss of vision with the annoying symptoms caused by inverted lashes, etc.

Permanent deformity of the lids, partial ptosis, limited movement of the ball, opaque cornea, and staphyloma are the frequent and distressing sequelæ of the dreaded disease.

It is caused by unhygienic habits of life, contagion, and scrofula.

The disease occurs most frequently among young persons between the ages of fifteen and thirty, and is usually binocular. Germans, Poles, Hungarians, Egyptians, and Italians are peculiarly susceptible to granular conjunctivitis, whether as the result of inherent peculiarities of temperament, or from neglect of sanitary laws, has not been definitely determined.

The prognosis is unfavorable. Complete recovery is rare. The disease lasts for years.

Treatment.—The affection is greatly modified by treatment, which is largely local. For the first stage, antiphlogistics and antiseptic remedies are indicated, such as leeching, applications of bichloride of mercury, 1–500 or 1–1000, scarification of the everted lids, and frequent cold water baths to the eye. After the granulations have formed, the treatment which at present would seem to promise the best results, is extrusion of the granules by expression with the roller forceps, while the patient is under the influence of anæsthesia. The older treatment, such as cauterization, the application to the granules of crystals of copper, or alum, or of the mitigated stick of the nitrate of silver (thirty-three per cent.), atropine, and inunctions of

yellow ointment of mercury is, at best, only palliative. It should be the surgeon's aim to abort or destroy the granulations. If pannus should form it must be combated by an incision of the blood-vessels from which those of the cornea are derived at the corneo-scleral border, and by instillation of atropine and frequent hot-water baths to the eye. In the third stage, or stage of cicatrization, diverted lashes should be removed, the entropion relieved by operation, and the contracted commissure widened, if any of these conditions are present as a result of the inflammation. The general system should be supported by tonics, pure air, good food and exercise. Confinement in a dark room should be avoided.

BLENNORRHŒAL, PURULENT, or GONORRHŒAL CONJUNCTIVITIS, or OPHTHALMIA NEONATORUM, is an intense inflammation of the ocular and palpebral conjunctiva with chemosis, hypertrophy of epithelium and papillæ, characterized by an excessive discharge of pus or muco-pus. It is acute in its course unless a sequel of acute catarrhal conjunctivitis. Within a few hours of its inception, the upper lid becomes greatly swollen, smooth, and shiny on its cutaneous surface. The lashes are grouped into bundles and covered with discharges. The lower lid is puffed out, pus and tears escape from the outer canthus, and the conjunctiva, infiltrated with serum, is elevated from the sclera, so that the cornea appears sunken. In a few days a section of the cornea loses its transparency, the epithelium is cast off, forming an ulcer, which, in the graver cases, advances to perforation with escape of aqueous, and, finally, to sphacelus of the entire cornea; or the inflammation moderates, swelling subsides, discharge lessens, and the products of inflammation are gradually absorbed without involvement of the cornea, or, if involved, it recovers with

opacity and, probably, anterior synechia. The prolonged inflammation, rather than its intensity, decides the question of corneal infection. The keratitis is induced by interruption of the blood supply, the result of pressure on the pericorneal and episcleral vessels from exudation in that region. The serum may become partially absorbed, but the conjunctiva is still elevated and uneven from the presence of more or less exudation. During and for several weeks after the termination of the acute stage, the conjunctiva of both lids, the upper lid more especially, projects in horizontal ridges with deep furrows between them resembling granular conjunctivitis, caused by the excess of inflammatory exudation, which persists long after the other symptoms of inflammation have subsided.

The cause is infection. Ophthalmia neonatorum is caused by the absorption by the conjunctiva of other as well as gonorrhœal pus. The mother giving birth to an infant which becomes, in a day or two, affected with this disease, is not necessarily a subject of gonorrhœa. In other words, the vaginal secretion causing the disease, is not always gonorrhœal in character. The inflammation primarily attacks one eye, and is conveyed by the inter-communicating nasal ducts, or by carelessness, to the other, or both eyes are affected simultaneously and from a single cause.

Treatment in the acute stage consists in applications of ice, or ice water, renewed every few minutes day and night, thorough cleansing of the conjunctival sac with saturated solution of boric acid, which should be squirted into the commissure every half hour by means of an eye-dropper, or absorbent cotton may be used for the purpose. Nitrate of silver (grs. v to ℥j or grs. x to ℥j, if the discharge of pus is abundant) should be applied to the everted lids once or twice daily. These remedies, with atropine (gr. iv–℥j),

when the cornea is threatened or attacked, are the most effective. In the subacute stage, nitrate of silver in diminishing strength, and at increasing intervals, until the palpebral regions are of normal smoothness, mild antiseptic washes, and vaseline applied to the lids at night to prevent the gluing together of their free margins, are indicated.

PHLYCTENULAR, LYMPHATIC, SCROPHULOSIS OR HERPETIC CONJUNCTIVITIS is a frequent affection among children. It is characterized by the formation in the conjunctiva of one or more blebs containing serum or pus. The vessels supply-

FIG. 43.

PHLYCTENULAR OPHTHALMIA, CONJUNCTIVAL FORM.

ing the affected region, are injected and pursue a tortuous course from the fornix to their endings at the phlyctenule. Other parts of the conjunctiva are but slightly, if at all, injected. The symptoms are not severe, except in the purulent form, and cause the patient little inconvenience. Attention to the diet, pure air, out-door exercise, the removal of the cause of reflex irritation, such as worms in the intestinal canal, and difficult dentition, the daily application to the margin of the lids of Pagenstecher's ointment, and thorough cleansing of the parts with a saturated solution of boric acid will, usually, cure the inflammation in a few days. Relapses

are likely to occur, involving the same or the other eye, or the two eyes simultaneously.

CROUPOUS CONJUNCTIVITIS is an acute, highly contagious inflammation of the conjunctiva, characterized by the formation *on* a part or on the whole of the conjunctiva of a thin, yellowish-white membrane, composed of albuminoid and cellular substances, which is detached without difficulty, leaving a bleeding point or surface. The disease has a tendency to recur. It is an infrequent affection, confined principally to children, and while the symptoms—swelling of the lids, chemosis, thin and abundant discharge, pain and heat—are severe, the cornea is rarely involved. During the formation of the croupous membranes, caustics must be avoided, and, instead of their use, ice compresses, antiseptic lotions, and powdered quinine, dusted over the diseased surface, employed. After the acute stage, a blenorrhœal conjunctivitis persists, and this is successfully combated by the application of the nitrate of silver (gr. v–℥j).

DIPHTHERITIC CONJUNCTIVITIS is an acute, intense, contagious inflammation, characterized by the deposition *in* the subconjunctival tissue of a yellowish-white membrane, so closely interwoven with the conjunctiva that its detachment is difficult. The local symptoms—swollen lids, extensive chemosis, acute pain, heat, and sanious discharge—are severe and very marked in character. There is superadded to them, in some cases, the constitutional symptoms of diphtheria. The cornea is often destroyed through ulceration. In the course of a week, the false membrane and surrounding conjunctiva become necrosed and slough off, leaving a deep ulcer, which heals slowly. A more or less extensive cicatrix remains to permanently alter the contour of the lid. When the characteristic diphtheritic pro-

cess has subsided, a purulent or semi-purulent conjunctivitis remains. The disease attacks one or both eyes, is sporadic or epidemic, may precede or follow similar membranes in the throat or nose, or run its course as a purely local affection.

The prognosis is not favorable. The treatment, during the formation and continuance of the membrane, is antiphlogistic and antiseptic. Atropine locally, and constitutional remedies, suited to the age and necessities of the patient, should be employed. Salivation is recommended in adult patients.

Xerosis is a dryness of the conjunctiva due to destruction of the papillæ and follicles through atrophy of the mucous membrane from severe and long-continued inflammation (diphtheritic or granular conjunctivitis), or to the improper and continued use of caustics. The functions of the eye are interfered with, and may be destroyed, through resulting opacities of the cornea. Treatment is of little avail. Constant instillations of glycerine is said to be palliative.

Pterygium is a vascular membrane, triangular in shape, closely resembling in appearance and structure the conjunctiva, on which it is superimposed. Its base corresponds with the curve of the sulcus at the inner canthus, and the growth extends horizontally until the apex has invaded the subepithelial layer of the cornea. Its apex may thus cover in part, or completely, the pupil. It may appear in both eyes simultaneously or be confined to one. In rare instances it is developed from the outer canthus. It is an affection of slow growth, and is most frequently found in elderly persons who have been exposed to wind and rain through many years of active, outdoor life. Sailors are

peculiarly liable to the affection. It should be regarded as an hypertrophy of the conjunctiva, the result of constant exposure to the elements, rather than as an inflammation.

FIG. 44.

PTERYGIUM.

TUMORS.—*Pinguecula* is a small, yellowish-white, fatty-like growth, usually noticed between the cornea and inner canthus. It is harmless. Granuloma, or Polypi are not infrequently found attached to the conjunctival surface after an injury or operation; they should be excised. Dermoid cysts, lipoma, sarcoma, and melano-sarcoma are also found in the conjunctiva. They should be removed and the wound cauterized.

PART VI.

DISEASES OF THE LIDS AND LACRYMAL APPARATUS.

CONGENITAL MALFORMATIONS.

COLOBOMA is a fissure of one or both lids, and is often associated with similar deformities of the iris, choroid, and palate.

EPICANTHUS (Fig. 45) is a widening at the base of the

FIG. 45.

EPICANTHUS.

nose, caused by a redundancy of the skin in this situation. The internal angle of each palpebral fissure is partly covered, and the fissures apparently shortened. When a fold of skin at the centre of the interpupillary space is elevated by forceps, the deformity temporarily disappears.

PTOSIS (Fig. 46), is a drooping, partial or complete, of the upper lid, from paralysis of the levator palpebræ branch of

the third nerve. This condition is most apparent when the patient's gaze is directed upward. The deformity may be relieved by operation.

TRAUMATISM.

Incised and punctured WOUNDS, involving only the lids, and not penetrating to the eye-ball, should be sutured and treated antiseptically with the double purpose of preventing deformity and promoting resolution.

FIG. 46.

PTOSIS.

BURNS from acids, alkalies, molten lead, scalding water, etc., may lead to disastrous results from the formation of cicatricial contractions, which terminate in distortion of the lids, adhesions between their free margins, and consequent narrowing of the palpebral fissure, and lead, not infrequently, to destruction of the conjunctival sac. The aim of the treatment is to prevent marginal and surface adhesions, and the formation of cicatricial and distorting bands, by traction and the constant application of oil dressings to the wounded

surfaces. When the wound is superficial, involving a large portion of the lid, skin grafting should be employed, and when the lid is destroyed, a plastic operation becomes necessary, the deficient or lost tissue being supplied from the adjoining parts.

CONTUSION, "black eye," is usually the result of violence, such as a blow. The loose connective tissue of the lids becomes swollen, ecchymosed, and presents a bluish discoloration, which is a source of annoyance rather than of danger. The condition may be speedily relieved by the alternate application of hot and cold water, to which is added, in the proportion of one to eight, the tincture of arnica, or a wash of the chloride of ammonium, gr. v–℥j, may be substituted.

INFLAMMATIONS.

PHLEGMON, ABSCESS, is an acute, purulent, circumscribed inflammation of the cellular tissue, attended with redness, swelling, pain, and localized elevation of the temperature. The abscess is at first hard, gradually increases in size, softens, and has a tendency to point through the skin. It may be the result of injury, of cold, or develop without assignable cause. When situated near the inner angle, the abscess should not be confounded with acute inflammation of the lacrymal sac.

A threatened abscess, may be aborted by the local application of cold, and by the internal administration of calcium chloride, of which a two-grain pill should be given every two hours until four pills are taken. When the inflamed area presents a central induration, poultices, followed by an early incision, parallel with the margins of the lid, are indicated. After incision, the parts should be frequently cleansed with antiseptic lotions, and supported by a compress.

HORDEOLUM, STYE, is a localized inflammation in or near the bulb of an eyelash. It rapidly advances to pustulation, and is accompanied by redness, pain and swelling, particularly when situated at the outer angle, and by local, and sometimes general, increase of temperature. There is usually a succession of styes, one following another at irregular intervals for several weeks or months. The cause is to be found in some refraction error, or in an impoverished condition of the system. Treatment: cold compresses in the early stage to abort, and hot poultices, later, to hasten suppuration. A small incision may be made through its apex, or the tumor left to open spontaneously.

BLEPHARITIS is an inflammation of the lids, acute or chronic, dependent upon disease of contiguous parts, such as the various forms of conjunctivitis, orbital disease, erysipelas, etc.

MARGINAL BLEPHARITIS is a chronic inflammation of the free margin of the lids. In its early stage, it is characterized by an induration around, and hypersecretion of, the sebaceous glands with the formation of minute pustules, which rupture, leaving small ulcers. The secretion, drying, forms crusts which become matted with the ciliæ. When the crusts are removed, the edge of the lid presents a series of excoriated and bleeding points. The entire margin is finally involved in the inflammatory process, the ciliæ fall out, and are replaced by a few fine and misdirected hairs, or they may be altogether absent. The symptoms are redness, swelling, itching, and a sensation of heat, aggravated by the use of eyes in near work, by smoke and other atmospheric impurities. It occurs in children and young adults, as a result of reflex irritation, ametropia, and scrofula.

Treatment.—The cause should be ascertained and re-

moved; the ametropia corrected by the proper lens; the reflex irritation from painful dentition, or from intestinal worms, relieved by suitable remedies, and in scrofula, tonics and alteratives administered with good food, fresh air, and healthy surroundings. The crusts should be dissolved by mild alkaline washes, sodii bicarb., or biborate, gr. v–℥j, the ulcers stimulated by touching them with a pledget of cotton soaked in silver nitrate, gr. v–℥j, and, once or twice daily, an ointment of the yellow or red oxide of mercury (gr. j, vaseline ℥j) applied, or, in stubborn cases, aristol in the same strength can be substituted for the mercury.

AFFECTIONS OF THE SKIN.

ERYTHEMA, ECZEMA, and ERYSIPELAS appear occasionally on the lids, as elsewhere on the body, as a local manifestation of the general affection. They are to be treated on the principles laid down for these diseases.

ŒDEMA is a symptom of orbital disease, of purulent conjunctivitis, and of nephritis. In all cases of œdema without local cause, the urine should be examined for albumin. It requires no special treatment.

EMPHYSEMA is an escape of air into the cellular tissue adjoining the lids, induced by violent sneezing, blowing the nose, and by asthma. Compression by a roller bandage is the only treatment necessary.

RODENT ULCER begins at the margin of a lid, usually the lower, as a small excrescence which, in time, falls off, leaving an excoriated surface. This slowly increases in size until it has destroyed, after the lapse of many months or years, the lid and neighboring tissues. The pain is inconsiderable. The treatment consists in the early and complete excision of the diseased part.

EPITHELIOMA presents in its initial stage similar appearances to the rodent ulcer, but is distinguished by the rapidity of its growth, lancinating pain, thin, offensive, ichorous discharge, and by its tendency to recur after excision. It occurs, as does the rodent ulcer, in elderly persons. Early excision is the treatment. The application of glacial acetic acid, repeated tri-weekly until the ulcer is

FIG. 47.

A.

MEIBOMIAN CYST.

B.

LID FORCEPS.
A, Screw. B, Shank.

cicatrized, has been advocated. It, together with other remedies of the same class that have been proposed from time to time, is not to be employed, however, when the patient is willing to submit to an operation.

LUPUS is a tuberculous infiltration of the lid, and occurs usually as an extension of the disease from neighboring structures. All treatment heretofore devised has been simply palliative. No cure has yet been found for tubercle.

XANTHELASMA is a fatty degeneration of the skin, of a bright yellow color, occurring in symmetrical patches on the lids of both eyes near their inner angle. They should be excised and the healthy skin drawn together by sutures.

CHANCRE is a specific, indurated sore of the lid, due to direct contagion, having the same features and followed by the same constitutional infection, that characterize chancre in other situations of the body. The treatment is anti-syphilitic and constitutional.

CHALAZION (Fig. 47, A) is a small cyst developed in the tarsal cartilage from obstruction of a meibomian duct, damming its secretion. It is a common but insignificant tumor, easily removed by excision.

ECCHYMOSIS is an effusion of blood beneath the skin or conjunctiva from traumatism, or from idiopathic rupture of a small vein. No treatment is necessary.

MILIUM is the name given to a minute, hard, pearly-like growth, situated on the margin of the lids, or in the skin. It requires no treatment, but may be readily removed if the patient so desires.

AFFECTIONS OF THE EYELASHES

TRICHIASIS (Fig. 48) is that condition in which the ciliæ assume, as a result of chronic disease of the conjunctiva, independent directions, some normal and others distorted. Those turned against the cornea should be pulled out, or their bulbs excised.

DISTICHIASIS (Fig. 49) is the condition in which there is a second irregularly placed row of lashes, congenital or acquired, partially or wholly in contact with the cornea. This is a painful complication of chronic conjunctivitis. Friction of the distorted hairs against the cornea produces a super-

ficial keratitis with permanent impairment of vision in some cases. The treatment is depilation. The hairs should be removed as often as they appear.

FIG. 48.

TRICHIASIS.

ALOPECIA is a falling out of the lashes due to granular conjunctivitis, blepharitis marginalis, or to constitutional disease (syphilis). The predisposing cause should be ascertained and treated.

FIG. 49.

PEDICULUS PUBIS, crab-lice in the ciliæ, are sometimes found in those who are filthy in their persons and surroundings. They cause intolerable itching, which is relieved,

and the crabs destroyed, by the daily application to the free margin of the lids of the yellow oxide of mercury ointment.

ACQUIRED DEFORMITIES.

ENTROPION (Fig. 50) is a partial or complete *inversion* of the ciliary margin of the lid. It is sometimes noticed as the temporary result of spasm of the orbicularis muscle, induced by the long-continued application of a pressure-bandage after operations, but is more often found as a per-

FIG. 50.

ENTROPION OF LOWER LIDS.

manent deformity, caused by atrophy of the conjunctiva and consequent abnormal convexity of the tarsal cartilage, from granular conjunctivitis, or traumatism. The affection is, in a large majority of cases, complicated by vascular inflammation of the cornea, and of the conjunctiva of the inverted lid. Temporary entropion is relieved by drawing, and holding, the edge of the lid outward by adhesive strips fastened to the neighboring skin. Many operations have been devised for the permanent cure of entropion, which is not easily remedied. Advancement of the tendon

of the palpebral muscle has, in our hands, given the best results.

Ectropion (Fig. 51) is a partial or complete eversion of the margin of the lid, and, like entropion, is sometimes found as a transient symptom of inflammatory swelling of the lid, or as a permanent deformity from paralysis of the orbicularis muscle. It is, however, most frequently caused by cicatricial contraction of the palpebral or neighboring integument, the result of destructive injuries, such as burns, wounds, etc., involving these parts. When of long

Fig. 51.

Ectropion of Lower Lid.

standing, the exposed conjunctiva becomes hypertrophied. From eversion of the puncta lacrymalia, tears collect in the conjunctival sac, and flow over the cheek, causing still more irritation. If the upper lid is affected, the cornea may suffer from adhesion of particles of dust. In the transient form, recovery of the normal position of the lid ensues when the cause is removed. In the permanent form, a plastic operation is the only measure by which relief can be obtained.

Blepharospasm is an involuntary closure of the lids from tonic or clonic spasm of the orbicularis muscle. The

abnormal contraction of this muscle is reflex, excited by photophobia, foreign body in the cornea, neuralgia, and by accommodative or muscular strain. The condition may manifest itself by an occasional twitching of the lids, so slight as to be hardly noticeable, local chorea, or, by the forcible closure of the lids, lasting a considerable length of time. The cause should be ascertained and relieved. In young persons, the defect will be found, in many cases, to be due to an error of refraction, or muscular anomaly, correction of which will result in a cure of the spasm. Division of the supraorbital nerve has been advised in otherwise intractable cases. If the affection is found to be due to some constitutional dyscrasia, remedies addressed to the general system, rather than to the local manifestation, will, of course, be indicated.

BLEPHAROPHIMOSIS is a narrowing of the palpebral fissure, consequent upon long continued inflammation of the conjunctiva. The proper length of the commissure should be restored by the operation of canthotomy or canthoplasty.

PTOSIS is a drooping of the upper lid from paralysis of the levator palpebræ muscle, or from an increase in weight of the lid in chronic thickening and induration. The former, is a symptom of central or spinal disease, when not due to an affection of the orbit. Iodide of potassium, mercury, strychnia and electricity, are proper remedies to employ when the initial lesion is in the cerebro-spinal system. Surgical interference is warranted under the same conditions that govern operations for paralytic strabismus.

SYMBLEPHARON (Fig. 52) is a cicatricial adhesion, partial or total, of the lid to the eyeball, the sequel of destructive inflammation of the conjunctiva from burns or extensive ulceration. It is relieved by operation.

ANYKLOBLEPHARON (Fig. 53) is a union of the free mar-

gins of the lids from traumatism or ulceration. Traumatism severe enough to cause complete adhesion between

FIG. 52.

SYMBLEPHARON.

FIG. 53.

ANKYLOBLEPHARON.

the ciliary margin of the lids, will also destroy the cornea, and treatment, under these conditions, is unavailing.

DISEASES OF THE LACRYMAL APPARATUS.

HYPERTROPHY of the lacrymal gland, the position of which is shown by dotted line, Fig. 54, is occasionally met with in young persons as a small, movable tumor situated in the upper and outer angle of the conjunctival sac. It is not attended by pain, or other signs of inflammation, but the eyeball, against which it rests, is pressed downward and inward, causing double vision, the chief symptom of which the patient complains. The treatment consists in the free administration of tonics, such as the syrup of the iodide of iron, cod-liver oil, etc., and in a nourishing dietary.

ABSCESS of the lacrymal gland is a rare affection, usually chronic, and is the result of injuries, and of chronic inflammations of the conjunctiva. Its presence is determined by

a fluctuating swelling at the site of the gland. It has a tendency to rupture through the skin, causing fistule, and should be incised as soon as fluctuation is determined.

FISTULE of the lacrymal gland is the sequel of an abscess that has opened spontaneously. It remains patulous because of the constant discharge through it of tears mingled with pus. The opening thus formed should be closed by cauterization, and a new one made into the conjunctival sac.

FIG. 54.

LACRYMAL GLAND.

MALPOSITION, or diversion of the puncta lacrymalia, which normally lie in contact with the conjunctiva of the ball, prevents the escape of tears which collect in the conjunctival sac, giving rise to epiphora, or watery eye. The condition is brought about by paralysis of the orbicularis muscle, chronic thickening and eversion of the lid from conjunctivitis, and by the other causes of ectropion. If the normal position of the lid cannot be re-established by massage, slitting up of one or both canaliculi, with their permanent transformation into gutters, will afford partial relief.

STRICTURE of the nasal duct may form in any part of its course, but the junction of the bony and cartilaginous portions is usually the site. It is caused by chronic inflammation of the conjunctiva, or of the Schneiderian mucous membrane of the nostrils, lessening the lumen of the canal. Its constant and annoying symptom is epiphora. A small swelling is common on the site of the lacrymal sac, which by pressure exudes tears and mucus backward through the canaliculi.

Blennorrhœa, Dacryocystitis, abscess, and fistule of the lacrymal sac, are common sequelæ of stricture.

(*a*) *Blennorrhœa.*—The mucous lining of the sac becomes inflamed from the presence and pressure of retained tears, forming a small tumor which exudes, when compressed, a glairy fluid (tears and mucus mingled) into the conjunctival sac, or downward through the stricture into the nostrils. This stage of the affection is termed *mucocele.*

(*b*) *Dacryocystitis* is a purulent inflammation of the lacrymal sac, following blennorrhœa as a later consequence of stricture, characterized by greater tumefaction, and by a discharge largely composed of pus, which the patient is compelled to express many times in the course of the day. Complaint is made of constant overflow of tears, pain and swelling at or near the inner angle of the lid, and of disturbed function.

(*c*) *Abscess* is the culmination of an acute dacryocystitis, and is manifested as a rapidly developing inflammation of the lacrymal sac with extensive invasion of the surrounding parts, such as œdema, redness, and excessive swelling of the lids, so great in some instances as to produce closure of the commissure. The sac is exceedingly sensitive to pressure, and the abscess, if allowed to pursue its course

uninterruptedly, will eventuate in necrosis of the bone, and in a fistulous opening through the skin.

(*d*) *Fistule* (Fig. 55) is the establishment of a pathological channel from the lacrymal sac to the cutaneous surface, through which the products of inflammation are discharged.

Treatment.—In the earlier stages of stricture, massage and the local application to the conjunctiva of astringents, injected by lacrymal syringe into the canaliculi, or simply

FIG. 55.

FISTULE OF LACRYMAL SAC.

dropped into the conjunctival sac, may be sufficient to abort the disease. The following is a useful lotion for the purpose:

℞. Boric acid, ... gr. v
Zinc sulphate, ... gr. j
Water, ... ℥j.

When it is clearly established that medication alone will not bring about a cure, the stricture must be either dilated or divided. This method of treatment is not in all cases satisfactory, and should be employed only when other and

less radical measures have proved to be unavailing. When, however, the swelling at the site of the gland contains pus, as well as tears and mucus, the operation can no longer be delayed with safety to the patient, or with credit to the surgeon. The local application of lead water and laudanum, leeches, attention to the bowels, kidneys and skin, may abort an abscess during its formative stage. When the tumor shows a tendency to point it must be freely incised. No attempt to pass a probe is advisable until the swelling and tenderness have subsided; it may then be treated as a stricture. The fistulous opening will usually close without direct medication when the normal passage for the escape of tears has been re-established; if, however, the natural process of healing is too slow, union may be promoted by cauterization of the walls of the fistule. When it is not convenient for the patient to see the surgeon every day or two, a substitute for frequent probing is the leaden or silver style, which may be introduced and allowed to remain in the duct for several weeks or months, for the purpose of keeping the stricture dilated.

PART VII.

DISEASES OF THE CORNEA AND OF THE SCLERA.

In corneal inflammations, the surrounding minute vessels, straight and parallel (terminals of larger conjunctival and subconjunctival vessels, which in health are empty of blood and invisible), are, with few exceptions, injected. This zone of vascularity is known as the *pericorneal ring*. Inflammations of the cornea (corneitis, keratitis) are divided into two classes, superficial and deep.

SUPERFICIAL AND VASCULAR.

In vascular inflammations of the cornea, newly formed arteries and veins, given off from the conjunctival vessels, ramify over the corneal epithelium. These vessels vary in size, length and number, involve a part or the entire surface of the cornea, appear early or late in the course of the disease, and may become entirely absorbed without leaving a trace.

PHLYCTENULE (Fig. 56).—Phlyctenular keratitis is characterized by the presence of one or more small cysts, which form on the limbus cornea, or in any other part of its surface, containing serum and lymph cells. The outer wall of the cyst is formed by the corneal epithelium. After the lapse of a few days, the bleb breaks through its epithelial wall and its contents escape, leaving an ulcer. In a few hours after the appearance of the phlyctenules,

vascular offshoots from the conjunctiva pursue a tortuous course to the diseased spot or spots. There is usually a leash of these vessels, four or five in number, with its base on the limbus and its apex in the phlyctenule. The disease manifests itself oftenest in children, especially those who have inherited a scrofulous diathesis, and is developed by improper nourishment, poor sanitation, and reflex disturbances (teething, worms, etc.).

The main symptoms are photophobia, lacrymation, and acute pain. The blister, characteristic vascularity, and resulting ulcer sufficiently mark the disease. If the phlyc-

FIG. 56.

PHLYCTENULAR ULCER.

tenule is single, it is usually found on the cornea in front of the pupil, or, if multiple, is manifested as a series of pin-point cysts or ulcers on limbus. The disease disappears without trace or sequelæ in ten or fifteen days, under proper treatment, which consists in restricting the diet, regulating the bowels, and in the use, locally, of yellow ointment and atropine.

HERPES is an accompaniment of catarrhal disease of the respiratory and intestinal tracts. One or more vesicles form on the cornea, in any situation, rupture and leave an ulcer with transparent floor, and clear cornea surrounding it, or, if infected by micro-organisms, the base of the ulcer

is yellow, and a considerable portion of the surrounding cornea infiltrated and destroyed. It should be treated as an ulcer.

PANNUS is a superficial vascular infiltration of the cornea with partial destruction of its epithelium, caused by granular conjunctivitis. The epithelial layer of the cornea, usually the superior half, in some instances the entire surface, is traversed by a leash of blood-vessels given off from the conjunctival arteries and veins. These newly-formed and tortuous vessels, largest at the periphery, are directed toward the centre of the cornea. There may be only a single vessel, or the entire corneal surface may be transformed into a velvety, beefy-looking mass with temporary destruction of vision. The cause is due either to friction of the roughened lids over the sensitive corneal epithelium, or to an extension into the cornea of the true granular process. The cornea between the vessels is infiltrated with lymph-cells, and on its surface are minute facets of ulceration. These pathological changes are usually limited to the anterior layers of the cornea, do not often involve the structures underlying Bowman's membrane, and affect primarily the cornea underneath the upper lid.

Pain, intolerance of light, lacrymation, swelling, and injection of the conjunctival and ciliary vessels, are the usual symptoms. Prognosis is, as a rule, favorable, notwithstanding the long duration of the cause, but the recurrent and extensive destruction of the epithelium, and infiltration, lead to some permanent impairment of vision, and, in some cases, to conical cornea, and to corneal staphyloma. Treatment is directed to the granular conjunctivitis, which is always the causes of pannus. Atropine and hot-water applications, in conjunction with the treatment of the granular lids, are useful.

Non-Vascular Superficial Keratitis.

Herpes is the name given to the appearance, in groups on the cornea, of minute round vesicles in an eye already affected by catarrhal conjunctivitis. Calomel dusted into the conjunctival sac is the only treatment required.

Ophthalmic Herpes Zoster is the formation, during an attack of frontal herpes, of a number of small vesicles on the cornea. These vesicles rupture, form ulcers, and leave opacities. There is incomplete anæsthesia of the cornea. The treatment is by atropine, pressure bandage, and by the internal administration of quinine, arsenic, and bismuth.

Resorption Ulcer is a superficial, non-vascular loss of corneal substance without severe symptoms. The pericorneal injection is not marked. The ulcer forms in an eye previously healthy, or in one which is already the seat of corneal or conjunctival disease. The bottom of the ulcer nearly always remains clear, and the surrounding tissue is not infiltrated. The disease shows little tendency to involve the iris. Atropine and local irritants, are the remedies indicated.

Profound Keratitis.

Deep Ulcer (Fig. 57) is inflammatory, differing from the resorption ulcer in its involvement of the deeper layers of the cornea, and in its tendency to perforate. It is a localized loss of corneal substance attended by signs of active inflammation. The floor and margins of the ulcer exhibit a yellowish discoloration, the adjoining parts are infiltrated, and pus forms in the anterior chamber (Fig. 58), hypopyon, or there is a collection of pus in the most dependent portion of the cornea, onyx. The inflammation is acute, the pericorneal and conjunctival injection marked, and iritis may complicate the affection and aggravate the attending symptoms—pain, photophobia, lacrymation, and

loss of function. The prognosis will depend on the size of the ulcer, its site, and on the severity of the inflammatory process. The more central the ulcer, the more damaging it will be to vision. All deep ulcers of the cornea leave a permanent cicatrix,—dense and white when complicated by iritic adhesion (anterior synechia).

Treatment.—Atropine, hot water, leeches to the temple, saturated solution of boric acid, applied every two hours, repeated and persistent cauterization of the floor and sides of the ulcer with the thermo-cautery, or silver nitrate (gr. xx–℥j), the instillation of eserine (gr. ss–℥j) every two hours

FIG. 57.

PERFORATING ULCER OF THE CORNEA, ADHESION OF IRIS (ANTERIOR SYNECHIA).

FIG. 58.

ONYX (6) AND HYPOPYON (4, 5).

during the day, and atropine (gr. iv–℥j) once or twice during the night, are indicated. Eserine is employed in threatened perforation to contract the pupil, thus diminishing intra-ocular pressure and supporting the tissues behind the diseased cornea, as well as for its beneficial local action on the cornea itself, while the atropine is given to prevent maximum contraction of the iris under myotic influence, and closure of the pupil by exudation. The pressure bandage may be employed. When spontaneous perforation is imminent, its worst features may be avoided by instrumental perforation. The treatment after perforation is

by antiseptic washings of the wound with a saturated solution of boric acid, eserine, and by a pressure bandage which is allowed to remain *undisturbed for 48 hours.* The general system should be supported by tonics.

SERPIGINOUS ULCER (Fig. 59) is a destructive purulent infiltration of the cornea with a decided tendency to advance in extent and in depth. It may attack any portion of the cornea, is usually longer than it is broad, arc-shaped, and surrounded by streaks of opacity running into the clear cornea. The ulcer is yellowish in color, attended by moderate signs of inflammation, and not infrequently manifests itself in persons whose general health is at a low ebb. It is often

FIG. 59.

ACUTE SERPIGINOUS ULCER OF CORNEA WITH CRESCENTIC BORDER OF INFILTRATION.

associated with disease of the conjunctiva and lacrymal apparatus. Onyx, hypopyon, and iritis, are frequently present. The treatment is the same as that given for other forms of deep ulcer.

INTERSTITIAL or PARENCHYMATOUS KERATITIS (Fig. 60) is a disease involving, as its name suggests, the deeper tissues of the cornea, which become infiltrated by lymph cells. The appearance of the cornea is that of a piece of ground glass. The epithelium is partly destroyed, and the iris lies hidden behind the gray opacity thus formed. The pericorneal injection is very marked, while that of the conjunctiva

is either slight or altogether absent. Vision is markedly reduced. Photophobia is intense, lacrymation profuse, but the pain slight; indeed, it is often altogether absent. The disease is slow and insidious, lasting from three weeks to many months. The opacity may entirely disappear, leaving, in the more favorable cases, irregularities in the corneal curve, or becomes dense and remains permanently. The iris may become adherent to the lens capsule, and occlusion of the pupil by inflammatory exudation occur. In the severer cases, blood-vessels are formed in the interstices of the cornea. The disease occurs among scrofulous, syphilitic, and anæmic young subjects, and is noted by some writers as a symptom of inherited syphilis.

FIG. 60.

INTERSTITIAL KERATITIS.

Treatment is by atropine, heat, dry or moist, locally, and by mercury, iodide of potassium, syrup of the iodide of iron, and other tonic remedies, systemically. The patient's eye should be protected from light, but not from the atmosphere.

ABSCESS begins as a single or multiple collection of grayish, inflammatory deposits in the corneal stroma, circumscribed by healthy tissue which eventually breaks down, forming a single large cavity containing pus. The color now changes to a straw-yellow, the surrounding cornea is striated, opaque, and bereft of its epithelium. Hypopyon and onyx are common. The abscess has a tendency

to increase in size until the enveloped pus and corneal debris are discharged through an anterior or posterior perforation. Iritis of severe type, is a usual complication of corneal abscess, which, in some cases, is even followed by capsular or lenticular cataract. Iritic adhesion to the corneal cicatrix, or the formation of anterior synechiæ, is a common sequel to perforating abscess, just as it is to perforating ulcer not preceded by collections of pus.

Abscess may occur as a result of traumatism, purulent conjunctivitis, the exanthematous fevers, paralysis of the fifth pair of cranial nerves, or from exposure, alcoholic excesses, and from the debility of old age. The symptoms are lacrymation, pain, photophobia, and loss of function.

Treatment.—Alternate instillations of atropine (gr. viij–℥j) and eserine (gr. j–℥j), as directed under the treatment for ulcer, should be employed, and the eye bathed frequently with a solution of the bichloride of mercury (1 to 3000). When the abscess threatens to perforate spontaneously, a free instrumental opening should be made by Saemisch's incision. After the escape of the aqueous and collapse of the anterior chamber following perforation, the cornea must be supported by a pressure bandage, which should be left undisturbed for seventy-two hours, except in blennorrhœal abscess, when the treatment is mainly directed to the diseased conjunctiva.

NEURO–PARALYTIC KERATITIS is caused by pressure upon, or disease of, the ophthalmic division of the fifth nerve, which has become paralyzed, the tissues supplied by it losing their sensibility. The cornea is destroyed through loss of nourishment, disintegration of the trophic fibres, or from exposure to foreign bodies, air, etc. The surgeon should endeavor to remove the cause, and to keep the lids forcibly closed throughout the continuance of the disease.

Necrotic Keratitis is a rapid destruction of the cornea without marked signs of inflammation, caused by marasmus, and other exhaustive diseases of infancy and early childhood.

Arcus Senilis, Annulus Senilis, is a partial or complete ring of fatty degeneration of the cornea about 1 mm. from the limbus.

Sequelæ of Corneal Inflammations.

Opacities of Cornea.—A *nebula* is a faint, *macula* an easily seen but translucent, and *leucoma* a dense, white opacity of the cornea. In young persons, or when the opacity is

Figs. 61 and 62.

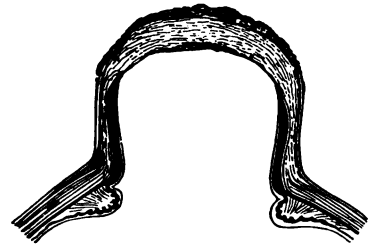
Partial Staphyloma of the Cornea and Iris.

recent, absorption may be induced by mild irritants, *e.g.*, finely powdered calomel dusted against the cornea, or yellow ointment applied to the margin of the lids once or twice daily. Eserine (gr. ss–℥j) dropped into the conjunctival sac daily, may also prove beneficial. To improve vision, an iridectomy, opposite clear cornea, may be made, providing a new pupil for the transmission of light.

Conical Cornea (Fig. 61) is a thinning and cone-like projection forward of the cornea, without alteration in its transparency, or other sign of inflammation. It is a chronic

and slowly progressive affection, the result of inherent weakness of the corneal stroma. It commonly occurs in persons between fifteen and thirty years of age, and is first subjectively noticed by a deterioration in vision, about which the patient will consult the surgeon. The condition is detected by the use of Placido's disc, or by the distorted image of a window frame on the patient's cornea, as well as by retinoscopy, in which the shadow is broken into a series of circular rings, and by the ophthalmoscope, which shows a varying degree of myopia as the gaze is directed through different parts of the cornea. The general refrac-

FIG. 63.



TOTAL STAPHYLOMA OF THE CORNEA AND IRIS.

tion is myopic, but a minus spherical, or a combination of a minus spherical and a minus cylindrical glass, will be found to be of very little service, since the cornea has many radii of curvature. Treatment is of very little value, either by correcting the refraction, or by operation.

STAPHYLOMA (Figs. 62 and 63) is a bulging forward of the opaque cornea, which has been so weakened by disease that it gives way to the normal pressure of the intraocular fluids. It involves a part, or all of the cornea, according to the intensity of the inflammation of which it is a sequel.

Frequently the iris and lens are dislocated forward into the deepened anterior chamber, the former adhering to the posterior surface of the staphyloma, and the latter becoming opaque. Secondary glaucoma, with ciliary staphyloma, are not uncommon complications, and blindness more or less complete is the rule. Treatment is unavailing. Amputation of the cornea or enucleation of the ball is indicated when the disfigurement is great, or the suffering severe. In children Critchett's operation is advisable, since the remaining stump includes two-thirds of the ball, and does not prevent development of the lines of the orbit, as does an enucleation performed in early life.

TUMORS of the cornea usually occur as extensions of inflammatory new formations from the conjunctiva, or from the deeper orbital tissues. Dermoid cysts, melanoma, pigmented sarcoma, and melanotic cancer may grow directly from the cornea. The treatment is by excision or enucleation of the ball. Recurrence of these growths is probable.

DISEASES OF THE SCLERA.

SCLERITIS is a localized inflammation of the scleral tissue, rheumatic in origin as a rule, characterized by slight swelling, pain on pressure, active injection of contiguous ciliary, deep pericorneal and conjunctival vessels, which impart to the diseased area a purplish hue. There are no signs of corneal or iritic involvement. The localized swelling and redness, and rheumatic history, render the diagnosis easy. The course of the disease is protracted, relapses frequent, and the pain severe. There may be temporary loss of function.

Treatment.—Dry heat locally, salicylates, phosphate of sodium by the stomach, and confinement of the patient

to warm apartments, in which the light is subdued, are indicated.

STAPHYLOMA (Fig. 64).—Anterior staphyloma, or ciliary staphyloma, is a bulging outward of the sclera in the ciliary region, the result of long-continued increased intra-ocular pressure, as in secondary glaucoma, and involves in its distention, the underlying portion of the ciliary body or choroid. The sclera becomes gradually thinner, assumes a bluish discoloration, and the portion of the uveal tract

FIG. 64.

STAPHYLOMA OF SCLERA.

involved in the process atrophies, and its place is occupied by inflammatory exudations. There may be one or more pea-sized staphylomata, or the entire anterior half of the globe may form a single large, staphylomatous mass, involving ciliary body, lens, iris and cornea. The function of the eye is entirely and permanently destroyed. Amputation (Critchett's operation), or enucleation of the ball, is to be performed, when the tumor is large enough to warrant surgical interference.

POSTERIOR STAPHYLOMA (Fig. 65).—The pathogenesis of

bulging of the sclera (non-traumatic) at the posterior pole of the globe, is dissimilar to the form just described. It is always present in high degrees of myopia, and its growth is dependent on the same causes that develop myopia. It is a true distention of the sclera, adjacent to the optic nerve, preceded by absorption of the choroid which so weakens it, that it cannot maintain its normal curve against the intra-ocular pressure. The true cause, and growth, of malig-

FIG. 65.

nant myopia, whether inherited or acquired, are associated with weakness of the sclera, and its tendency to stretch, in this situation. The process is chronic and not attended by any evidences of inflammation in the sclera or adjoining coats. The staphyloma is at once seen by the ophthalmoscope as a white placque, limited to one side (temporal), or surrounding the nerve with irregular small blotches of pigment distributed over its surface, traversed by retinal

vessels. It is more or less distinctly bounded by choroidal tissue. Occasionally in advancing, or very high myopia, a second distention, joined to the first by a small ridge of normal sclera, and known as secondary staphyloma, is found. Patches of atrophied choroid in the foveal region, detached from the staphyloma, are not unusual.

PART VIII.

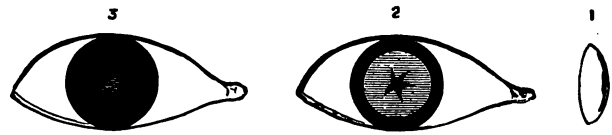
DISEASES OF THE CRYSTALLINE LENS AND LENS CAPSULE.

LENTICULAR OPACITIES.

CATARACT is an opacity of the lens, either congenital or acquired, and under these two heads the various forms of cataract are divided.

CONGENITAL CATARACT is a development during intra-uterine life, as a consequence of anomalous structure or of embryonic disease, of certain distinctive opacities, which

FIG. 66.



POSTERIOR POLAR CATARACT.

have been classified and described under the following appropriate headings:—

(*a*) CENTRAL CATARACT is a small, round, dense white spot in the nucleus.

(*b*) ANTERIOR POLAR CATARACT is an aggregation of numerous minute points of opacity grouped around the anterior extremity of the axis of the lens, sometimes associated with, and dependent on, pyramidal capsular cataract (exudation from the iris).

(*c*) POSTERIOR POLAR CATARACT is a similar opacity at the posterior pole of the lens, produced, probably, by the premature abolition of the hyaloid artery. Anterior and posterior polar cataract frequently co-exist in the same lens, and may be united by a line of opacity (fusiform cataract).

(*d*) ZONULAR or LAMELLAR CATARACT, the form most frequently found, is an opacity involving one or more layers or strata of the lens about half-way between the periphery and nucleus, the portions within and without this ring remaining transparent. The opaque lamella is seen by the ophthalmoscope to be of a dull gray color, sharply defined from the surrounding clear cortex, through which an indistinct view of the fundus can sometimes be had. The diagnosis is easily made when the pupil is dilated.

TOTAL CONGENITAL CATARACT.—The lens is either entirely opaque at birth, or opaque in its centre, the opacity rapidly advancing during the first few months of extra-uterine life, in the latter case, until the whole lens is opaque. The lens is at first soft and of normal size, but eventually shrinks and hardens from calcareous transformation. It is usually hereditary.

It is of interest to know that while the varieties of cataract described above are in the majority of cases congenital, others, that resemble them in every way, are *acquired* through traumatism, local inflammations, and general disease, such as rachitis, convulsions, etc. Congenital cataract may be monocular or binocular. The acuity of vision in any given case, will depend on the degree and extent of opacity in the pupillary area. Some subjects are enabled to pass through the school period, learning to read, write, etc., while others will be enabled to distinguish large objects only. Late in life, congenital cataracts are

inclined to become wholly opaque. The treatment is by discission, or iridectomy.

ACQUIRED CATARACT.—Traumatism, local inflammations, and debilitating constitutional affections, may produce cataract at any age. The pathological process is primarily a disturbance of nutrition, and secondarily a disturbance of the anatomical relations of the strata of the lens—absorption of the fluid, and sclerosis of its fibrous elements. In young individuals, twenty-five to thirty-five years old, the lens is soft, and lenticular opacities occurring in persons under the age of thirty years, are designated "soft" cataracts, while the term "hard" cataract is applied to opacities occurring in older persons.

Traumatism, perforating corneal ulcer, chronic iritis and cyclitis, choroiditis, detachment of the retina, retinitis pigmentosa, and diabetes, are among the ascertained causes of cataract in the young. Treatment: discission.

SENILE CATARACT.—The word senile is employed to describe opacities occurring in persons of greater age than thirty years, and which can be ascribed only to senile change. Of course, the causes that are operative in the production of cataract in the young, are also operative in its production in older persons, and cataracts thus produced are not, properly speaking, senile, but secondary—secondary to traumatism, or to disease.

Senile cataract is either "incipient" or "mature." The former is said to be *nuclear* when its starting point is in the centre, and *cortical* when the opacity begins in the periphery of the lens.

It may be observed, in connection with the natural history of cataract, that a myopia of 3^D or 4^D, due to swelling of the lens, usually precedes the loss of transparency. The

Congenital Lamellar Cataract.
(Dilated Pupil).

Congenital Lamellar Cataract advanc
ing to Total (Dilated Pupil).

Incipient Nuclear Cataract
(Dilated Pupil).

Incipient Nuclear and Cortical
Cataract (Dilated Pupil).

Cortical Cataract (Dilated Pupil).

Cortical Cataract (Undilated Pupil)

Congenital Capsular Cataract
(Dilated Pupil).

Irregular Lenticular and Capsular
Cataract (Dilated Pupil).

opacity commences as a few short streaks, seen as dark lines by the ophthalmoscope, in the cortex at the line of union of the different lens segments, or as a circular dark body limited to the nucleus, the process advancing by involvement of neighboring clear tissue until the entire lens is included. The period of growth from incipiency to maturity varies in different cases. It may be completed in a few months or in the longer lapse of years. Mature cataract becomes hypermature by a further tissue metamorphosis, the cortex becoming fluid, the fibres broken and irregular, and the lens shrunken, and infiltrated with myelin, cholesterin, and calcareous formations.

Among the clinical features of cataract, it may be noted that one eye is, as a rule, first affected, its fellow following in the morbid process after a varying lapse of time. The patient suffers no pain, and consults the surgeon for the relief of gradually failing sight, which is very likely attributed to the lack of proper glasses. All objects are seen through a veil or mist which increases to blindness, or perception of light only, with increasing and finally complete opacity of the lens. Such patients will very often not seek advice until the second eye is affected. By oblique illumination, the lens will show dark streaks, or areas, behind the pupil. By the ophthalmoscope, the opacity is clearly outlined against the red reflex of the fundus until the cataract is very nearly matured. The opacity is fixed, moving only with the movement of the ball (diagnosis between lenticular and vitreous opacity), and is seen immediately behind the pupil.

A cataract is "ripe," and ready for operation, when, by oblique illumination, the opacity is seen on a plane, or nearly on a plane, with the pupillary margin, when vision is reduced to the perception of large moving objects, such

as the hand, twelve inches away from the eye, and when light projection is possible in all parts of the visual field. (Patient is directed to look straight forward, and correctly give the position of the light as it is moved by the surgeon in the different situations. This the patient will only do when there is no serious defect of the eye ground.) Exceptionally, cataracts should be extracted before maturity, *e.g.*, when both lenses are involved to the extent of prohibiting the necessary occupation of life. It is conservative surgery to operate on the eye first affected, when both are ripe.

Treatment: extraction. Ninety per cent. regain useful vision.

Traumatic Cataract.—A contusion of the ball, rupturing the lens capsule, disturbance of the anatomical arrangement of the layers or sectors of the lens, or laceration of its capsule by a foreign body, whether or not the lens is pierced, will lead to a partial or complete opacity of the crystalline body. As a rule, the entire lens participates in the morbid process. Immediately following the injury one or more stripes of opacity radiate through the lens, which swells and partly protrudes into the anterior chamber, where partial absorption takes place. Iritis is a frequent accompaniment of traumatic cataract.

Treatment: in young subjects the lens will probably undergo absorption without operation; in elderly persons, it must be extracted.

Dislocation of the Lens may exist congenitally, but it is more often acquired. A congenital anomaly of the vitreous or choroid is the underlying cause in the former, and the latter, may be ascribed to contusions, or to the direct and forcible contact of a foreign body. The lens substance

usually becomes opaque, although it sometimes retains, in the congenital form, its transparency for many years. No treatment is advisable. In acquired dislocation of the lens, extraction should be performed when possible.

APHAKIA, absence of the lens, is most frequently met with in persons upon whom discission or extraction has been performed. The diagnosis is made by the history, the appearance of the eye,—deep anterior chamber, trembling of iris, absence of the small inverted image of a candle held a short distance from the eye (Purkinje's sign), high degree of hypermetropia, and by the loss of accommodation.

Treatment: glasses for far and for near.

DISEASES OF THE CAPSULE OF THE LENS.

DEPOSITIONS ON THE ANTERIOR SURFACE are found, such as the remains of the embryonic pupillary membrane, the exudation from iritis, and cicatrices from temporary adhesions to the cornea, following perforating ulcer. On the posterior surface, the terminal remains of the hyaloid artery, and the deposition of irregularly shaped flocculi, precipitated from the vitreous, are occasionally found.

WOUNDS.—The capsule of the lens may be lacerated, and this injury is followed, in young persons, by retraction or gaping of the divided margins, produced by extrusion of lens matter, and by partial opacity of the anterior portion of the capsule. Slight wounds of the capsule in elderly persons are inclined to heal. Opacity of the capsule anteriorly, together with opacity of the adjoining lens, may entirely clear up.

SECONDARY CATARACT is a loss of transparency of the capsule following, in a few weeks, extraction of the lens.

Treatment.—When the opaque capsule occupies the pupillary space, an opening should be made in its centre by means of two needles, or by division with a small sickle-shaped knife; or, when possible, the opaque capsule should be extracted through an opening made in the cornea near its scleral margin.

PART IX.

DISEASES OF THE UVEAL TRACT.

CONGENITAL ANOMALIES OF THE IRIS.

ANIRIDIA is an absence of a part, usually the pupillary margin, or of the entire iris. It is an uncommon affection, and is found associated with other congenital defects, such as posterior polar cataract, or microphthalmus.

COLOBOMA is a fissure of the iris, with its base at the pupillary margin, and its apex at or near the periphery. A similar defect in the ciliary body and choroid coat often co-exists. It is an indication of arrested development.

PERSISTENT PUPILLARY MEMBRANE.—The pupillary space is occupied in the fœtus by a thin, web-like membrane which occasionally remains after birth, as a few fine threads, running obliquely across the pupil, attached to the anterior surface of the iris. They might easily be mistaken for posterior synechiae, but their origin from the anterior surface and not from the inner pupillary border, their fineness and uniformity of outline as contrasted with the irregularly shaped and dentated inflammatory adhesions, as well as their very slight influence on the mobility of the iris, will determine the diagnosis.

POLYCORIA is a multiple pupil, formed by an imperfect coloboma, or by the remains of a persistent pupillary membrane, which divides the otherwise normal pupil into two or more spaces capable of contraction and expansion.

ALBINISM is that congenital condition in which the uveal

tract, the hair, eye-brows and lashes, contain no pigment cells. When the subject faces a bright light, the red reflex of the fundus shows through the pupil and interstices of the iris. Indistinct vision, from the imperfect absorption by the choroid of the rays of light and from myopia, congenital or acquired from the necessity of holding objects close to the eye, and photophobia, are invariably present.

DISEASES OF THE IRIS.

HYPERÆMIA OF THE IRIS is an abnormal fullness of its vessels preliminary to iritis, or accompanying inflamma-

FIG. 67.

POSTERIOR SYNECHIA.

tion of the cornea, or of other and deeper-seated portions of the eye. It is recognized by the presence of enlarged vessels on the surface of the iris, its indolent response to variations of light, and by its lessened expansibility under the influence of mydriatics. The symptoms of hyperæmia are those of the disease it inaugurates or accompanies.

PLASTIC IRITIS (Fig. 67).—The conjunctiva in plastic iritis,

the most common inflammation involving the iris, is usually inflamed and chemosed, with a deep-seated partial or complete pericorneal zone of purplish vascularity. The iris, which also shows increased vascularity, is discolored and tumefied, and discharges on its surface, and in its parenchyma, a tenacious lymphoid exudation, which quickly and permanently binds, if the disease is left uncontrolled, its pupillary border to the anterior surface of the lens capsule, thus forming *posterior synechia.* The synechiæ, discolored by an intermixture of pigment from the uveal tract, visibly project in ragged edges from the pupillary margin. These adhesions may unite a part of the pupillary border to the anterior capsule of the lens, partial synechia, or the entire posterior surface of the lens may be adherent to the lens capsule (total or complete synechia), annihilating the posterior chamber. The pupillary space may be in part or altogether occluded by the membranous exudation, and, in such instances (they are not infrequent), the capsule immediately behind this space, is likely to become opaque, and the mobility of the iris lost. In this condition its response to mydriatics, is nearly or completely abolished, and the functions of the eye temporarily destroyed; for vision is diminished in proportion to the extent and density of the exudation. Pain in the ball, radiating to parts supplied by the supra-orbital and infra-orbital branches of the fifth nerve, is felt. Increased lacrymation and intolerance of light, are also marked symptoms. Tension remains normal. Sensitiveness over the ciliary region is excessive. The disease runs a course of from two to six weeks, or even longer. Chronic iritis as an independent affection rarely, if ever, exists.

The word "chronic" as applied to plastic iritis, has reference to the recurrent acute attacks, which are prone to occur

from a disturbance of function caused by attachments between iris and capsule, or from chronic inflammation of the neighboring parts.

Iritis may under treatment recover without sequelæ; usually, however, synechia and minute patches on the lens capsule, mark the sites of adhesive exudation, and vision may be destroyed through pupillary occlusion. It is not infrequently found that a complete annular synechia remains, cutting off communication between the anterior and posterior chambers through the ordinary pupillary channel, and secondary glaucoma is the natural and inevitable consequence, unless the inter-pupillary communication is reestablished by iridectomy. It is the duty of the surgeon, when the existence of this condition is definitely determined, to urge this operation, and to refuse to treat the case if the patient declines its immediate performance.

It is not always easy to determine the cause of plastic iritis. It is consecutive to inflammation primarily involving any portion of the uveal tract, and to traumatism. The presence of a foreign body may set up a plastic iritis, or it may arise idiopathically. The common cause of the disease, are syphilis, gonorrhœa, rheumatism, and scrofula, or tuberculosis.

Treatment is local and constitutional. The patient should be confined to a properly ventilated but darkened room. Atropine (gr. viij–℥j), hot-water bathing, and leeches to the temple, are to be employed, and actively employed, locally. If the disease is due to traumatism, the appropriate local treatment should be instituted; if the outbreak is of rheumatic origin, the salicylates are indicated; if syphilis is the cause, the patient should be mercurialized to the point of mild salivation, and mercury in lessening doses with the iodide of potassium, administered during the continuance of the

inflammation. The mercurials may be omitted if the affection is due to gonorrhœa. In a word, the cause, whatever it may be, should be treated on general principles, independently of the local affection, the patient's strength nourished, and the general system built up by a generous dietary, tonics, and fresh air.

Serous Iritis, Descemitis (Fig. 68), is recognized by the presence on the posterior surface of the cornea of a collection of minute points of exudation, and by a similar exudation, combined with larger and denser flakes, floating in the anterior portion of the vitreous chamber. The iris reacts sluggishly to the stimulus of light and accommo-

Fig. 68.

Serous Iritis.

dation, and may present one or more minute posterior synechiæ. Light does not pass readily through the flocculated cornea and vitreous, and there is a resulting deterioration of vision. The details of the fundus are indistinctly seen by the ophthalmoscope. The nerve is ill-defined, and the retinal vessels veiled, as in neuro-retinitis. These appearances are due, as a rule, to the clouded media, but in some instances are the results of a co-existing optic neuritis. The pain and injection are inconsiderable; they may, indeed, be altogether absent, and indistinct vision the symptom of which the patient most complains. The course of the disease is chronic, its etiology obscure, and the treat-

ment unsatisfactory. Mydriatics, mercurials and the iodides are, however, employed. The nutrition of the lens is disturbed, streaks of opacity appearing in the cortex, followed by total opacity of the lens, in a small proportion of cases.

PARENCHYMATOUS, OR SUPPURATIVE IRITIS.—In simple plastic iritis, exudation from the inflamed membrane is largely deposited in the anterior chamber and pupillary space, but in parenchymatous iritis, the inflammatory exudates are mostly confined to the tissues of the iris, which become swollen and spongy in consequence, and its color changes to a yellow or greenish-yellow, as the lymphoid cells undergo transformation into pus. The pupillary border of the iris is hypertrophied and thickened by fibrinous exudations, which project into, and sometimes obliterate, the pupillary space. The characteristic sign of purulent iritis, is the deposition in the anterior chamber of pus, which, less consistent and more fluid than the hypopyon of keratitis, is absorbed and re-formed rapidly. Commonly there is a formation in one or more sections of the iris of small collections of cells, tuberculous or gummatous according to the origin of the disease. Vision is generally permanently impaired. The treatment is practically the same as that already given for the plastic form of iritis, and should be pushed energetically and persistently.

MYDRIASIS, DILATATION OF PUPIL, is (1) *Idiopathic* when it persists for many years in one or both eyes, or alternates from one eye to the other, and is associated, in most cases, with paralysis of accommodation. It is likely to obtain in several members of a family, and exists without apparent cause other than heredity. (2) It is *artificial*, and transient, when the result of the instillation of a mydriatic; (3) *symptomatic* when it is the reflex of a lesion in the brain or spinal cord, or from intra-ocular, or extra-ocular pressure; (4) *emo-*

tional when due to anger, fright, or nervous excitement. If the mydriasis is long continued, the local instillation of eserine may be beneficial. If, however, the mydriasis is due to a lesion of the cerebro-spinal system, treatment is unavailing.

MYOSIS, CONTRACTION OF THE PUPIL, is (1) *artificial* and transient, when the result of the instillation of a myotic (eserine); (2) *irritative* when the 3d nerve, or its pupillary branch is excited to excessive action by central irritation, induced by the presence of a tumor, or by the continued, or strong contraction of other branches of the 3d nerve; (3) *reflex* when due to neuralgia of the 5th nerve, or to intestinal irritation; (4) *paralytic* when the pupillary fibres in the cervical and dorsal plexus of the sympathetic are compressed or diseased from traumatism, aneurism, or other causes. Local treatment is useless when the myosis is the symptom of a central lesion.

"ARGYLL-ROBERTSON PUPIL" is that condition in which the pupil contracts under the impulse supplied by the stimulus of the 3d nerve in the acts of convergence and accommodation, but not to the stimulus of light.

HYPHÆMIA, or hemorrhage into the anterior chamber from the vessels of the iris, is *spontaneous* in sudden alteration in the tension of the ball, in glaucoma, and in menstrual irregularities; and *traumatic*, in wounds, contusions and lacerations of the iris. In atrophied eye-balls, which are the seats of old hemorrhages, cholesterin crystals are sometimes found in the anterior chamber. Treatment is unnecessary.

DETACHMENT OF THE IRIS from the ligamentum pectinatum, may occur as the result of a severe blow, and is always attended by hyphæmia, and by partial and temporary loss of vision. After the blood has been absorbed, the eye may regain normal vision. No treatment will restore the iris to its former position.

TUMORS OF THE IRIS.

CYSTS.—One or more cysts, ranging in size from a pin-head to a pea, with solid or fluid contents, the result usually of traumatism, may form on any part of the surface of the iris, and are attended with moderate inflammatory symptoms. They, together with the underlying iris, should be excised at the earliest possible moment.

TUBERCLE is a collection of small, whitish elevations containing tuberculous matter, scattered over the surface, and coexist with similar growths in the choroid. They precede, or are developed, in a small proportion of cases, during general tuberculosis.

GRANULOMA is a small benign tumor, resembling in appearance a granulation of the conjunctiva. The treatment is by excision with iridectomy.

GUMMA is a syphilitic tumor, springing from the stroma at the pupillary border, or near the periphery of the iris, and consists of a mass of spindle-shaped cells, gummous exudation, and newly-formed connective tissue, brownish-yellow in color, round in outline, vascular at its base, and projecting as far forward, in some instances, as the posterior surface of the cornea. It makes its appearance at the end of the second or the commencement of the third stage of constitutional syphilis, and, like gumma in other parts of the body, is amenable to mercury and potassium iodide administered in large doses.

DISEASES OF THE CILIARY BODY.

CYCLITIS, or inflammation of the ciliary body, is rarely an independent affection, but usually associated with disease of the iris or choroid, and should be considered as a complication, or concurrent symptom, in connection with inflam-

matory disease of these tissues. It is, therefore, an extension of inflammation of the iris, or choroid to the ciliary body, characterized by an increased sensibility to touch in the ciliary region, and by the presence of opacities in the anterior portion of the vitreous humor.

Treatment.—Locally, atropine, hot water applications, and leeches to the temple. Internally, mercury and the iodides, or jaborandi.

SYMPATHETIC OPHTHALMIA.—The course of sympathetic inflammation is marked by two distinct and separate degrees of advancement, the stage of *irritation* and the stage of *inflammation*, which must be unmistakably recognized. The first stage, always the precursor of the second unless promptly discovered and checked by operation, is declared by a decrease in the range of accommodation in the eye not primarily affected, by photophobia, lacrymation, slight pericorneal injection, sluggishness of the iris under the stimulus of light and of accommodation, and perhaps, by tenderness upon pressure over the ciliary region. Following, these symptoms, is the inauguration of the second stage with exudation into the anterior chamber and pupillary space, vitreous opacities, pain, moderate swelling of the optic nerve, and œdema of the retina. The flame is now well lighted up in the eye, and, with the supervention of hypopyon, iritis, occlusion of the pupil, opacity of the lens, shrinking of the vitreous, and retino-choroiditis, goes on to panophthalmitis, atrophy, and destruction of the ball.

The disease is transmitted along the ciliary nerves, or the lymphatic sheath of the optic nerve, or both.

It may be caused by a foreign body, hernia of the iris, anterior synechia, dislocated lens, a cysticercus, trauma-

tism, bony formation in the vitreous chamber, or by the irritation of an artificial eye.

Treatment.—Enucleation of the eye inducing irritation, in first stage; local remedies, and mercurialization for the irido-choroiditis, in second stage, with enucleation of infecting eye, if it is hopelessly blind.

Chronic Cyclitis is the term given to a chronic inflammation involving nearly all the tissues of the eye, eventuating in the abolition of function, and in atrophy of the ball, *phthisis bulbi.* As a result of traumatism, an unsuccessful cataract extraction, for example, the uveal tract becomes inflamed, the iris totally adherent to the lens capsule, pupil occluded, lens capsule and lens opaque (if not previously extracted), ciliary body destroyed (atrophied), vitreous opaque and shrunken, retina detached, and the choroid disorganized. The cornea, which may or may not be opaque, is lessened in its diameters. If inflammation should subsequently attack the eye thus destroyed, as not infrequently happens, the occurrence of a sympathetic inflammation in the sound eye is to be apprehended, and guarded against. After the lapse of years, the vitreous body of an eye destroyed through chronic cyclitis, is replaced by a button of bone, deposited very gradually from the choroid, which, acting as a foreign body, irritates the ciliary nerves by constant friction, and leads to sympathetic involvement of the sound eye. An atrophied eyeball is, therefore, a constant menace to the integrity of its fellow, and the only conservative treatment is enucleation.

DISEASES OF THE CHOROID.

CHOROIDITIS.—In inflammation of the choroid, its stroma is infiltrated with amorphous masses of exudation and collections of densely packed cellular elements at the periphery, pole, or in the neighborhood of the optic nerve, varying in size from a minute point to the patches of the diameter of the disc, or even larger. The pigment layer of the retina is always disturbed. The pigment cells are either absorbed or undergo proliferation, collecting in masses at the circumference of the patch. The exudate becomes absorbed in the later stages of the disease, its site being marked by an absence of pigment as well as of vessels, and the overlying retina is partly destroyed through cicatricial contraction. The patches vary in shape, but are either round or oval as a rule. The vitreous contains opacities, and is generally fluid. In purulent choroiditis, pus cells are dispersed everywhere through the meshes of the choroid and retina, and may completely fill the vitreous chamber.

The retina and choroid are so intimately associated in structure and function, that chronic disease of the one must involve the other. The names given to the various clinical manifestations of choroidal and retinal disease depend on the membrane in which it originates, but in every case it is a *retino-choroiditis*. The effect on vision of retino-choroiditis will depend on the site of the exudation, whether central (at or near the fovea) or peripheral, and on the amount of retinal tissue destroyed. It is much less, as a rule, than the ophthalmoscopic appearance would indicate.

DISSEMINATED CHOROIDITIS (Fig. 69) is a collection of small, roundish aggregations of yellowish, subsequently white, exudation, surrounded by deposits of pigment,

scattered at first irregularly throughout the periphery, and, finally, in the neighborhood of the disc and macula. They rarely increase in size.

Areolar Choroiditis (Fig. 70).—In this form of choroiditis the patches, fewer in number and larger in size than in disseminated choroiditis, are deposited here and there throughout the fundus.

Central Choroiditis is a limitation of the inflammatory and atrophic changes to the macular region.

Central Senile Atrophy is characterized by absorption of the choroidal tissue and destruction of the retina at and around the fovea, preceded, possibly, by apoplexy of the choroid.

Central Guttate Choroiditis (Fig. 71) is the term employed to designate the deposition, immediately behind the retina, of from six to twelve minute chalk-like aggregations involving the fovea, or adjacent to it, and associated with partial destruction of the retina. It is commonly found in old persons.

Ophthalmoscopic Appearances.—By the aid of the ophthalmoscope, the observer is enabled to determine variations from the normal in color, together with the size, site, shape, approximate number and character, of the discolorations described above. In the earlier stages of choroidal disease, the patches present a yellowish hue, which gradually assume, as the choroid is absorbed, the bluish-white color of the sclera, and are distinctly outlined by a black border of pigment. They vary in size and number, and are irregular in shape. Occasionally a choroidal vessel is found running across the patch. Among the patches, too, are often seen small black pigment spots, irregular in outline, which appear to be situated in the retina, as determined by their relation to the retinal vessels. The difference of level be-

FIG. 69.

ATROPHY AFTER SYPHILITIC CHOROIDITIS, SHOWING VARIOUS DEGREES OF WASTING.

a. Atrophy of pigment epithelium. *b*. Atrophy of epithelium and chorio-capillaris; the large vessels exposed. *c*. Spots of complete atrophy, many with pigment accumulation.

FIG. 70.

CENTRAL CHOROIDITIS (*Wecker and Jaeger*).

tween the centre of the patch and the adjoining fundus is always difficult, and sometimes impossible, to estimate; if, however, the choroidal vessels have disappeared, and the retinal vessels pass over the affected spot, it is safe to assume that the choroid is the main and original seat of the disease.

In disseminated choroiditis the spots are numerous, and average about half the size of the disc. They are found,

FIG. 71.

CENTRAL GUTTATE SENILE CHOROIDITIS.

in the earlier stages of the disease, scattered over the equatorial zone. In areolar choroiditis the patches are larger, several times the diameter of the disc, but fewer in number, and usually involve the posterior pole. Round masses of pigment are spread, in its earliest stages, through the fundus, but these undergo gradual absorption, beginning in the centre and advancing to the circumference, leaving a white spot traversed by retinal vessels and outlined by

pigment. The pigment line, in turn, is often girdled by a zone of opaque retina. The earliest change discernible by the ophthalmoscope in central choroiditis, is a collection of pigment spots in a mass of exudation, elevating the retina at and in the immediate neighborhood of the fovea. As the disease advances the spots become confluent, the exudation shallower, and the branches of the small retinal vessels turning toward the fovea are seen to bend at the margin of the plaque. Eventually the choroid atrophies, and the overlying retina is destroyed, presenting the general appearances noticed in other forms of choroiditis. The whitish patch involving the foveal region in central senile atrophy, is preceded by no ophthalmoscopic evidence of inflammation. In choroiditis guttata, the ophthalmoscope reveals a collection, surrounding the fovea or between the fovea and disc, of pale yellow and glistening white dots, which have no clinical significance.

In all forms of acute choroiditis, vitreous opacities are discernible by the ophthalmoscope.

Symptoms in General.—The main symptom is an impairment of vision, the character and degree of which will depend on the site of lesion, the extent of retinal implication, and vitreous opacities. The visual declination is, it may be remarked here, not so great as the ophthalmoscopic appearances would lead one to suppose. The patient will complain of a grayish or blackish defect in the centre of the object in view (positive scotoma), or, later on, of an utter effacement of the object in its centre (negative scotoma), or of a distortion of the object (metamorphopsia), and of sparks or flashes of light or color when the lids are opened or closed, owing to an irritation of the retinal elements (photopsia). The patient will complain, too, of spots or

clouds which float before the sight, especially marked in a bright light.

In purulent choroiditis, the *pseudo-glioma* of some writers, vision is lost in a few hours because of the quick destruction of the choroid and retina. Pus can easily be seen, by oblique illumination, collected in the vitreous chamber. The anterior chamber is shallow, iris and lens adherent, and both pushed forward by the purulent mass.

The causes of choroidal disease are numerous. Congenital and acquired syphilis, traumatism, metastatic infarction due to epidemic and sporadic cerebro-spinal meningitis, and other contagious fevers, pyæmia, endocarditis, and high myopia, may be mentioned.

Treatment.—In its early stages or manifestations, the disease may be cured, or at least checked, by the energetic employment of the mercurials and iodides. The cause must be ascertained and treated on general principles.

PART X.

DISEASES OF THE VITREOUS.

HYALITIS.—Inflammation of the vitreous is not an independent affection, but a development of cyclitis or choroiditis. It is characterized by a change of consistency, opacities, and by partial disorganization of its own tissue. The opacities are of three varieties, namely, clouds of fine dust, significant of syphilitic disease of the choroid; membranes, following hemorrhage, retinal detachment, and syphilitic chorio-retinitis; and threads, or irregularly-shaped, dense, separate flocculi, seen in high grades of myopia, and in the various forms of chronic choroiditis. Purulent infiltration and degeneration of the vitreous frequently follow the entrance into the chamber of foreign bodies, choroiditis metastica, entozōon, etc., and eventuate in phthisis bulbi.

MUSCÆ VOLITANTES are minute physiological vitreous elements, causing a subjective sensation of shadows floating before the eye, not revealed by the ophthalmoscope, and while their existence is annoying, they are of little pathological importance. The causative agency is supposed to be ametropia, since they are dissipated by its correction.

SYNCHISIS is the name given to a fluid condition of the vitreous.

SYNCHISIS SCINTILLANS is the designation given to an accumulation of cholesterine and other crystals in the

vitreous, revealed by the ophthalmoscope as glittering or silver-like reflections which move in all directions.

The prognosis of vitreous opacities should always be influenced by the reflection that they are, in fact, the floating wrecks of a preceding destructive inflammation of the choroid and retina,—the visible marks of an inflammatory storm in these parts.

Treatment is not encouraging. In opacities due to syphilitic disease, some improvement may be expected from mercury and the iodides. In a word, the underlying cause must be discovered and combated. The syphilis may yield to treatment, the hemorrhage be absorbed, and the foreign body removed by the proper treatment.

Persistent Hyaloid Artery.—In intra-uterine life the lens is supplied with blood from the hyaloid artery, a straight vessel given off to the posterior surface of the lens from one of the branches of the central retinal artery. It persists, as a fibrous cord, with its anterior end either attached to the posterior surface of the lens or floating unattached in the vitreous, in a small proportion of cases, and can easily be seen with the ophthalmoscope.

Foreign Bodies, such as metallic chips, splinters of wood, shot, etc., are sometimes driven with great force through the external coats of the eye, and find lodgment in the vitreous chamber. It is a serious accident, terminating in the partial or complete destruction of the ball from supervening purulent inflammation, and is, moreover, a prolific source of sympathetic ophthalmia. The diagnosis is determined by the presence of a superficial wound, sudden loss of vision, reduced tension, blood in the anterior and vitreous chambers, and, in some instances, by the ophthalmoscope and magnetic needle.

A foreign body in the vitreous sometimes becomes en-

cysted, and remains for years without giving rise to serious symptoms. Its removal, by means of a magnet, is advisable when practicable. If vision is completely and permanently lost, leaving a painful ball, enucleation should be promptly performed.

PART XI.

GLAUCOMA.

Glaucoma is a disease characterized by abnormally increased intra-ocular pressure, usually and arbitrarily described under two main divisions, *primary* and *secondary*. The primary is subdivided into non-inflammatory or simple, and inflammatory.

Simple Glaucoma is a gradually advancing blindness with attendant, probably consequential, excavation of the optic nerve—"amaurosis with excavation." Its pathology is not understood. The symptoms are not readily suggestive of the disease. The patient complains of gradually diminishing vision, and nothing more, as a rule. Even the pressure symptoms are negatively conspicuous. In truth, the symptoms of simple glaucoma are so little characteristic, that a diagnosis between cataract, atrophy of the nerve from other causes, and simple glaucoma can be determined only by the ophthalmoscope; and even with this instrument as an aid to diagnosis, it is not always possible to definitely determine whether the cupping of the nerve is a precedent and independent, or a subsequent and dependent, condition. The cup, usually involving the entire disc, is shallow, surrounded by a narrow zone of atrophied choroid, and the arteries on the disc pulsate spontaneously, or can be made to pulsate by pressure of the fingers on the globe. The field of vision is limited concentrically, or the nasal field contracted, while the extreme temporal field, with

possibly one or more scotomata, is preserved to the last. Both eyes are, in the majority of cases, affected, although the disease is further advanced in one than in the other, when the patient comes under observation. If the patient seeks advice at a certain stage of the affection, it may be found that one disc is totally and the other only partially cupped. The disease runs a very chronic course, several years intervening before blindness is complete. Complete restoration of vision is rarely attained. The progress of the disease may be controlled, under favorable conditions, by operation.

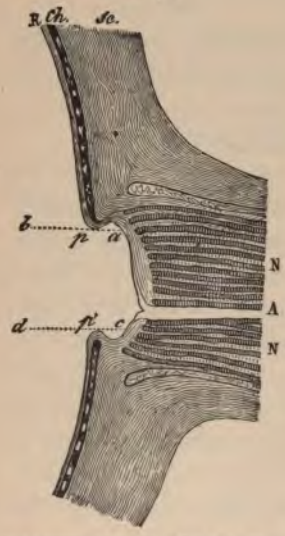
Treatment.—Eserine; iridectomy; sclerotomy.

CHRONIC INFLAMMATORY GLAUCOMA.—In reference to the pathology of chronic inflammatory glaucoma (Figs. 72 and 73), it may be stated that changes in the periphery of the iris, which lead to partial closure or obliteration of the spaces of Fontana, thus preventing the outflow of intra-ocular fluids, are common. But whether these changes in the iris are primary and causative, or secondary and incidental to the glaucomatous process, is a question that has never been definitely determined. The immediate effect of such occlusion or obliteration of the spaces of Fontana is to add to the amount of intra-ocular fluid, and hence to increase intra-ocular tension. Other pathological processes, namely, peripheral adhesion of the iris to the cornea through inflammatory exudation, vascular engorgement of the iris and ciliary body, atrophy of the ciliary muscle, obliteration of the choroidal vessels and atrophy of its tissue, closure of the lymph spaces, sclerosis and degeneration of the retina and optic nerve, are directly due and traceable to increased tension. This form of glaucoma is characterized by the occurrence, following a premonitory stage of vary-

ing duration, of attacks of true glaucoma, lasting from twelve to twenty-four hours.

The symptoms of the premonitory stage are: (1) early presbyopia, or a recedence of the near point, due to pressure on the ciliary muscle, the patient requiring a stronger

FIG. 72.



GLAUCOMATOUS EXCAVATION OF THE OPTIC NERVE. (*Vertical section.*)

FIG. 73.

GLAUCOMATOUS EXCAVATION. (*Ophthalmoscopic view.*)

plus glass for reading than the age would indicate, and there may be also a real diminution of refraction (acquired Hypermetropia); (2) a colored ring is seen around a gas flame, caused by slight opacities in the media and by the dilated pupil; (3) periodic obscuration of vision and ciliary neural-

gia due to temporarily increased pressure. The objective signs present are increased tension, as determined by palpation over the closed lid, or directly on the sclera (normal tension is expressed by the letters Tn.; slightly increased tension by Tn. + 1; undoubtedly hard by Tn. + 2; stony hard by Tn. + 3; when slightly less than normal, by Tn. — 1; undoubtedly soft by Tn. — 2, very soft by Tn. — 3); pulsation of the arteries on the disc, either spontaneous or easily induced by pressure on the globe. The intra-ocular pressure is so high that the blood enters the ball only with the systole of the heart, interrupting the continuous flow through the artery, thus producing a systolic pulsation. This sign is not infrequently found in aortic disease, and in exophthalmic goitre, and is occasionally found in persons apparently free from cardiac disease. *Venous* pulsation has no pathological significance. The retinal veins are hyperæmic, tortuous, and expanded in calibre. The pupil is dilated and sluggish, a direct consequence of pressure on the ciliary nerves. There is, lastly, some opacity of the aqueous humor from the exudations of venous stasis.

The prodromic stage may be said to be at an end, and true glaucoma begun, when, following one of these periodic attacks, the symptoms just described are unusually pronounced, with marked deterioration of vision. Each successive attack is progressively severe, and occurs at lessening intervals, until the eye presents the distressingly characteristic appearances of glaucoma with vision entirely destroyed. The ciliary vessels are injected, the anterior chamber shallow, the pupil widely dilated and immobile, the iris atrophied, the lens partly opaque and slightly dislocated forward, the disc surrounded by a ring of atrophied choroid, and the eye, now blind, is the seat of periodic attacks of pain of the most excruciating character.

Treatment.—During the premonitory stage, an attack may be warded off by the instillation of a solution of eserine sulphate (gr. ij–℥j), repeated every two hours until the symptoms are relieved. When the disease is unmistakably developed, iridectomy should be at once performed.

Acute Inflammatory Glaucoma.—A sudden outbreak of this disease, preceded in some cases by prodromic symptoms, is announced by unmistakable signs. The conjunctiva is chemotic, the anterior ciliary and pericorneal vessels intensly injected, the cornea presents a steamy appearance and is denuded of its epithelium, the anterior chamber is shallow and the aqueous humor turbid, the iris widely dilated, oval and unresponsive to light, and but feebly, if at all, contracted by eserine, and the color of the pupillary space is grayish-green from opacity of the cornea and aqueous humor, and from reflection of light from the lens. The fundus is invisible. The patient complains of intense ciliary neuralgia, the pain radiating over the forehead and down the side of the nose, and of rapid and complete loss of vision, which is due to paralysis of the retina and optic nerve from excessive pressure. The attack lasts several days. The signs of pressure slowly subside, pain is diminished and finally disappears and vision is, in part, restored, although the eye never entirely regains its lost functions. Or, the acute may gradually pass into the chronic form of the disease. An eye once attacked by acute glaucoma is predisposed to subsequent attacks. The optic nerve becomes excavated several days or weeks after the acute onset has subsided. The performance of iridectomy should immediately follow the diagnosis.

Fulminating Glaucoma is the term applied to those cases in which the above conditions are most pronounced, and vision is lost in a few hours.

Treatment.—Iridectomy.

SECONDARY GLAUCOMA is a result of certain local, chronic inflammatory diseases in which the intra-ocular pressure becomes permanently increased with excavation of the optic papilla. Among the causes thus operative, may be mentioned anterior and annular synechiæ, traumatic cataract, dislocation of the lens, and intra-ocular tumors. The prodromal stage is wanting. The symptoms are identical with those of chronic inflammatory glaucoma. Prognosis is unfavorable.

Treatment.—Iridectomy or sclerotomy.

Glaucoma may be complicated with other diseases, such as cataract, detachment of the retina, atrophy of the optic nerve, etc. Its etiology is obscure. It affects persons who have passed the middle of adult life,* and preëminently those of a gouty diathesis.

GLAUCOMATOUS DEGENERATION.—After an eye has been in the condition of absolute glaucoma for a varying period of time, which cannot be accurately stated, it undergoes secondary changes of a degenerative character. Its volume may be decreased from ulcerative processes in the cornea, through which the cataractous lens and part of the fluid vitreous are expelled by hemorrhages from the diseased vessels of the retina and choroid, *phthisis bulbi*, or the weakened sclera, unable to resist the abnormal intra-ocular pressure, becomes staphylomatous, and the diameters of the ball enlarged. During the period of glaucomatous degeneration, the globe is, ordinarily, the seat of intense pain. The ball should be enucleated.

---

* Mr. Priestly Smith has advanced the theory, based on numerous carefully conducted examinations, that idiopathic glaucoma is, in the main, dependent on an increase in size of the crystalline lens which, he claims, is common in advancing life.

PART XII.

NON-INFLAMMATORY DISEASES OF THE RETINA.

HYPERÆMIA is an increase in length and width of the large retinal vessels, recognized by their lateral and vertical tortuosity, dark color, pronounced light reflex, which extends far out toward the periphery of the fundus, by an increase in the apparent number and size of the smaller twigs, and by the color of the optic disc, which presents a deep red appearance so nearly the color of the surrounding fundus that the normal contrast in color between the two parts is almost lost. Pulsating veins on the disc are not infrequently found in the absence of disease, and are not pathologically significant, when moderate and confined to the superior and inferior veins, but pulsation of the smaller veins, and especially when it is noticeable some distance from the trunk, must be accepted as an evidence of disease.

Hyperæmia of the retina and nerve, when it is not the initial stage of an acute inflammatory process, is an indication of local irritation from ametropic strain, an associated symptom of disease of the uveal tract, or an evidence of central congestion or inflammation. The normal retinal variations are so great, that the diagnosis is difficult.

The cause should be determined and treated on general principles.

ANÆMIA of the retina is a symptom of constitutional dyscrasia. The calibre of the arteries is decreased, and

they are less numerous, relatively, on the disc than in health. The veins are unaltered, or slightly tortuous, and the disc pale.

EMBOLISM OF THE CENTRAL RETINAL ARTERY (Fig. 74) is a clot or embolus, which cuts off the retinal circulation, and is immediately followed by complete and incurable blindness. The distal branches assume a thread-like

FIG. 74.

EMBOLISM OF THE CENTRAL ARTERY OF THE RETINA.

appearance, and have no light reflex. The veins are thin, the disc white, and pulsation in the arteries or veins cannot be induced by pressure on the ball. Degeneration of the retina rapidly follows. It becomes opaque; the opacity being more pronounced in the region of the fovea, in which situation a well-marked, round, red spot (the choroid thus showing its normal color through the thinnest portion of the retina by contrast with the surrounding opacity) is dis-

tinctly seen. Atrophy of the retina and nerve follow. Embolus of a branch of the central artery of the retina is occasionally found, and the part of the retina nourished by the affected vessel, becomes opaque, the veins dilated, and localized hemorrhages, which appear as dark red blotches, with flame-like marginal serrations, occur. Vision is lost in the section of the field governed by the diseased retina.

Embolus is caused by hypertrophy and valvular disease of the heart, atheroma, pregnancy, and Bright's disease.

Treatment is of no avail.

The pathological changes of retinitis are modified by the cause, nature and tissue limitations of the process. The inflammation may be limited to the retina, or involve the optic nerve, papilla and choroid.

In œdema, the fibre and nerve layer of the retina is infiltrated by serum, which separates its elements into spaces of varying size. The fibres are compressed, opaque, granular, and swollen. The entire retina may be affected.

In hemorrhagic retinitis, the blood primarily escapes into the nerve-fibre layer or immediately below it, and thence into the other layers, destroying the elements by compression. The interstitial coagula may extend forward into the vitreous. The blood-cells break up finally, and the portion not absorbed is changed into lymph corpuscles, which form whitish or yellowish plaques. In extensive hemorrhage, the retinal pigment is disturbed and a pigmented cicatrix formed. Small hemorrhages may be, and frequently are, entirely absorbed.

Hemorrhage of the Retina is a single, or multiple effusion of blood. It occurs, without preceding inflammation, as the result of a blow, high myopia, choroidal disease, or as a symptom of some functional or organic disturbance

in other situations of the body. The exuded blood collects in one or more spaces, which are separated, one from the other, by compressed retinal tissue, and undergoes partial or complete absorption. The unabsorbed portion of the blood is formed into collections of lymph-cells, with alterations in the underlying pigment. Retinal hemorrhage is easily recognized by the ophthalmoscope as flame-shaped, or round, dark-red spots in the neighborhood of the disc or fovea. The presence of non-traumatic hemorrhage into the retina, is indicative of some grave disorder in other parts of the system—diabetes, or atheroma of the vessels, for instance.

Opaque Nerve Fibres is a shiny, white and irregularly band-shaped opacity, a continuation forward into the fibre layer of the retina, of the white substance of Schwann, which normally stops at the scleral opening. It is physiological, and its only effect on vision is to increase the size of the blind spot.

INFLAMMATORY DISEASES OF THE RETINA.

Hemorrhagic Retinitis.—In this affection, the most prominent ophthalmoscopic symptom is extravasations of blood in the retina. The hemorrhagic areas are minute and numerous, scattered here and there throughout the fundus, and are, as a rule, in close proximity to the larger arteries. Spots of hemorrhage also appear on and in the immediate neighborhood of the swollen disc. The retina is opaque from œdema, the veins large, dark and tortuous, the arteries are conversely small, some of them appearing as white lines devoid of blood. The disc is hyperæmic, its outlines obscured by exudation, and small parallel fine stripes, hypertrophied nerve fibres, radiate from it into the retina. Yellow, or whitish round patches (old hemorrhages,

fatty degeneration, or choroidal exudation) are seen in the retina. The vitreous is partly opaque from hemorrhages into its substance from the choroid or retina.

The retinitis may be considered either as the cause of the extravasation, as in neuro-retinitis from cerebral tumor, or as a result of it. In the latter case, the hemorrhagic spots are not so numerous, and are limited, moreover, to the retinal section in which an infarction or embolus has occurred, or exclusively to the region of the macula.

The effect on vision, depends largely on the extent and site of the hemorrhage, and on the proportion of nerve and retinal tissue destroyed. Examination will reveal one or more scotomata, central or peripheral, with diminution of central vision from œdema of the retina and vitreous opacities. The disease may involve one or both eyes.

Treatment must be determined by the cause. Rest, leeching, and counter-irritation are indicated locally.

Albuminuric Retinitis (Fig. 75).—The retina in this disease, is the seat of pathological changes. The papilla is œdematous and swollen, the surrounding retina œdematous, and slightly detached. The rods and cones are partly destroyed. The nerve-fibre layer is infiltrated with exudation. The fibres are hypertrophied, sclerosed, or transformed at intervals along their course into granules and fat cells, especially marked in the region of the macula. The vascular walls are thickened, and the lumen of the vessels contracted. Hemorrhages occur in the fibre and granular layers.

Ophthalmoscopic examination reveals a hyperæmic and swollen disc, the outlines of which are lost, parallel white lines or stripes running into the retina, swollen veins, normal arteries, small hemorrhages in the neighborhood of the disc, round, white, small isolated patches of granular and fat cells,

and a stellate series of bright, glistening stripes of hypertrophied and infiltrated fibres, which radiate from the macula. From these appearances, the diagnosis of kidney disease is easily made.

The disturbance of vision is not so great as the appearances thus revealed might lead one to suppose. The acuity

FIG. 75.

RETINITIS ALBUMINURICA.

of central vision is moderately reduced, but there is no limitation of the field, no scotoma, nor loss of color perception.

The retinal changes occur, as a rule, late in the course of the disease, are chronic in character, and involve both eyes. They vary with the intensity of the kidney affection. If the nephritic inflammation is relieved, the eye lesions may

entirely disappear. Ordinarily, however, the diagnosis is grave.

Treatment is general and symptomatic.

Retinal hemorrhages, hemorrhagic retinitis with plaques of white degeneration, paleness of the disc, distended and tortuous veins, and vitreous opacities, are frequently observed as localized expressions, in many of the severer blood affections, such as leucocythemia, pernicious anæmia, and in diabetes insipidus and mellitus. Treatment should be directed, as in albuminuric retinitis, to the primary disease. To promote absorption of the hemorrhage, iodide of potassium in small doses is recommended.

Diffuse Chronic Retinitis is pathologically characterized by an infiltration of the retina, the inner layers more especially, with lymph cells, numerous along the vascular areas, followed by the growth of interstitial connective tissue. The nerve fibre and molecular layers, thickened and permeated in spots by retinal pigment, finally atrophy, destroying in part the rods and cones. The choroid, in the majority of cases, participates in the morbid process as a disseminated choroiditis, and the optic nerve is swollen from infiltration of solid and fluid exudation.

By the ophthalmoscope the papilla is seen to be hyperæmic, the edge of the disc indistinct, the choroidal ring veiled by œdema, the retina around the disc opaque, the opacity fading peripherally to the normal reflex, the arteries reduced in calibre, the veins distended, and all vessels more or less veiled in the neighborhood of the disc by the retinal opacity, which is more marked in this situation. The fluid vitreous is filled with fine, dust-like opacities, which float in clouds, or appear as dense and large membranes. Circular patches of atrophied choroid, surrounded by pigment, are frequently found near the periphery. Corneal

opacities and the marks of an old iritis, are sometimes observed.

Symptoms.—Diminished central vision, particularly in dull light, floating clouds or spots, photopsia, metamorphopsia, slight limitation of the field peripherally, deficient color sense in the late stages, and, frequently, scotomata. Diffuse chronic retinitis may be either monocular or binocular, is chronic in its course, liable to relapses, and ends, unless treated energetically, in atrophy of the optic nerve and retina.

Tertiary and congenital syphilis, chronic choroiditis, and sympathetic inflammation, are among the common causes of the disease, which may, however, arise idiopathically.

Treatment consists in local blood-letting, counter-irritation and mercurial inunctions, carried to the point of salivation, and in the liberal exhibition of the iodides.

Retinitis Pigmentosa (Fig. 76) is chronic in its manifestations. Gradually the nervous elements of the optic nerve and retina atrophy. The layers of the retina, which is involved in its entire thickness, are infiltrated with pigment, which collects in great abundance in the fibre layer, and especially along the blood-vessels at their bifurcations. Cystic degeneration occurs in places with complete destruction of the rods and cones. The vascular walls, arterial and venous, are thickened and their lumen so diminished that they appear peripherally as white lines or fibrous cords. The optic nerve is finally completely atrophied.

Symptoms.—Central and peripheric vision slowly declines until the perception of light is lost, the field contracting concentrically, central vision being retained to the last. Night blindness (hemeralopia) is one of the earliest symptoms of which the patient complains. Pigment spots of

curious shape, not unlike bone corpuscles, more numerous peripherally than around the disc, are revealed by the ophthalmoscope. These spots are greatest in number at the bifurcation of the larger vessels. The disc is white, the arteries and veins reduced in number, size and calibre,

FIG. 76.

RETINITIS PIGMENTOSA.

and are accompanied by white lines. The light column is very fine, or altogether lost.

The disease, usually developed in young persons, is hereditary, a frequent taint in the offsprings of consanguineous marriage, continues through a long course of years, and affects both eyes.

Treatment is of very little value; electricity and strychnine may, however, retard its course, and should be employed.

DETACHMENT OF THE RETINA (Fig. 77) is a separation from the choroid of all except its pigment layer. The detachment may be confined to a small area, or include the entire retina from the optic nerve to the ora serrata. It is caused by the sudden or gradual discharge of fluid from the choroidal vessels, the exudation of solid inflammatory new formations, the development of choroidal tumors, or

FIG. 77.

OPHTHALMOSCOPIC APPEARANCE OF DETACHED RETINA (ERECT IMAGE). *After Wecker and Jaeger.*

by contraction of the connective tissue elements of the retina. The detached retina floating forward in the vitreous is not at first appreciably changed from the normal, but it eventually becomes degenerated, thickened and opaque, from a diffuse hyperplasia and consequent atrophy of its nervous elements. The subretinal fluid is thin, yellowish in color, and contains fat, lymph, blood-cells, and cholesterin. The fluid may be altogether sanguineous. The vitreous is opaque, partly fluid, and partly transformed into connective tissue. Tension is diminished.

Symptoms.—There is a sudden loss of a part of the visual

field, the position and extent of which corresponds to the position and extent of the retinal detachment. Central vision is deteriorated, objects distorted or only seen in part, and black opacities float in the visual field. As the fluid changes its position, gradually subsiding to the most dependent portion of the fundus, the blindness correspondingly alters. A portion of the field is usually retained for a long period of time, but is eventually, and gradually, lost through cataractous formation, or other degenerative changes.

The ophthalmoscope shows a blue-white or gray reflex, much nearer the observer's eye than the bright red reflex of the healthy fundus surrounding it. The detached retina, which is seen most clearly with a strong convex glass (20^{D}), floats in wavy undulations, and, adhering to its uneven surface dark lines, vessels from which the central bright line of reflex has disappeared, are seen. Floating vitreous opacities are invariably present.

Detachment of the retina is caused by traumatism, high myopia with posterior staphyloma, tumors, hemorrhage, cysticercus, and, perhaps, by uncorrected presbyopia. The prognosis is unfavorable, although in a small proportion of cases, the retina returns to its normal position under treatment.

Treatment.—The patient should be kept in recumbent position, a pressure bandage applied over the eyes, and hypodermic injections of pilocarpine, gr. $\frac{1}{6}$, repeated often enough to insure profuse perspiration, are administered. When the detachment is not caused by tumor, high myopia, or other evident organic change, an operation by which the subretinal fluid is allowed to drain off, is advisable.

Acute Central Retinitis, the result of exposure to

direct sunlight, or to the reflection of the sun on snow or water, is an active inflammation of the foveal region, characterized by metamorphopsia, and central scotoma for white and colors. The ophthalmoscope shows one or more white spots at the fovea, circumscribed by a zone of redness, which gradually shades off into the normal color of the fundus. The severity of the lesion will depend upon the length of time the eye has been exposed to the light. Complete recovery is unusual, but amelioration of the disease follows active treatment by strychnia, electricity, local bleeding during the congestive stage, and protection from light.

HYPERÆSTHESIA of the retina is a condition sometimes found in anæmic, hysterical women, and in hypochondriacal men, and gives rise to concentric, or irregular limitation of the visual field, and to deterioration of central vision. Lacrymation, photophobia, and blepharospasm are accompanying symptoms. The ophthalmoscope shows no evidence of disease. Remedies should be addressed to the cause, the eyes put at rest, protected from light, and the system built up by tonics.

ANÆSTHESIA of the retina is a rare, functional consequence of latent muscular insufficiency with co-existing ametropia. The acuity of vision, and the visual field, may be at first normal, but invariably deteriorate during examination. The patient suffers from accommodative and muscular asthenopia. The treatment is to correct the error of refraction by lenses, and the muscular anomaly by tenotomies.

GLIOMA OF THE RETINA is a cancerous growth, composed of softened nerve tissue infiltrated with small round cells, which spring from the retina. It is of rapid development,

invading the optic nerve, surrounding parts in the orbit and skull, and terminates fatally in a few months.

Treatment.—Extirpation of the eye-ball. The disease shows a singular tendency to reappear in the second eye, or in the brain.

CONTINUED EXPOSURE to bright light, or to its reflection from water or snow, or to dazzling flashes of lightning, may lead to structural changes in the retina near the fovea. They are revealed by the ophthalmoscope as a closely united collection of pale-yellow and small round spots. Patients suffering from this affection, complain of metamorphopsia, and of diminished central vision or of negative scotoma. It is in some cases modified by treatment, but usually leaves the vision permanently crippled, the result of destructive changes of the retina at the fovea.

Treatment consists in rest, and in protection of the eyes from light, in small doses of potassium iodide and mercury, and, locally, in blood-letting and counter-irritation.

PART XIII.

DISEASES OF THE OPTIC NERVE.

The physiological variations of the optic nerve as seen by the ophthalmoscope are numerous, and by this means alone one is often unable to differentiate between them and pathological conditions. The disc in health varies in color; it may be white with few vessels, or so red, from the presence of fine vessels, that it differs very little from the normal choroidal reflex; it may show black points of pigment, or be partly or wholly surrounded by a well-marked pigmented ring of considerable breadth; its surface may be plane, or it may present a small excavation in its centre, or nearly the entire disc may be physiologically cupped, and clearly show, at its bottom, the mottled connective tissue web of the lamina cribrosa. Venous pulsation may be present or absent. The size and divisions of the arteries and veins in health are not invariable. In many cases, all areas of the visual field for white and colors, and for scotomata, must be determined by the perimeter, and the acuity of vision ascertained, to confirm the previous diagnosis by the ophthalmoscope.

Optic Neuritis (Fig. 78).—This affection is characterized by hyperæmia of the disc, which is heightened in color from the presence of numerous small vessels, exceptionally seen in the normal eye, and by an obliterative exudation of inflammatory products into its excavation. The clear outline of the disc, thus swollen by serous and solid exuda-

tion is lost, and imperceptibly fades into the retina. The veins are distended and pulsate, the arteries either normal or reduced in size, while both arteries and veins are, in part, hidden by inflammatory exudates. The retina, in immediate proximity to the nerve, is streaked, thickened, and slightly opaque. In mild cases of optic neuritis, those usually classified as hyperæmia, the changes just cited are so slight that

FIG. 78.

OPTIC NEURITIS.

it is extremely difficult to arrive at a correct diagnosis; on the other hand, they may be so considerable, as in choked disc, that even the site of the nerve can be only negatively determined by the blood-vessels. In the latter case, small hemorrhages on or near the disc are common.

PAPILLITIS is an inflammation limited to the intraocular end of the optic nerve. The signs manifest by the ophthal-

moscope, correspond to those described in optic neuritis, and affect the disc and retina immediately around it.

NEURO-RETINITIS involves the retinæ, as well as the optic nerve, as in albuminuric retinitis, and is characterized by hemorrhages, patches of fatty degeneration, hypertrophy of its nervous elements, and deposition of pigment.

Symptoms.—Gradual failure of central vision. The visual field is contracted peripherally, or in sectors for white and colors, and these may involve one-half the field (hemianopsia). Central color scotoma is an occasional symptom. There is an absence of pain.

In optic neuritis there is an exudation of serous and plastic material in and about the papilla, perivasculitis, formation of new blood-vessels, swelling of the nerve fibres, and œdema of the optic sheath just behind the sclera. At a later stage of the morbid process, the intercellular infiltration is transformed into connective tissue which, by pressure, cuts off the supply of blood to the nerve fibres, causing them to atrophy, or to undergo fatty degeneration.

Among the numerous causes of optic neuritis may be mentioned brain and orbital tumors, injuries to the skull, simple and tubercular meningitis, erysipelas, periostitis, anæmia, diabetes, Bright's disease, diphtheria, scarlet and typhoid fever, measles, etc.

Optic neuritis due to incurable constitutional or orbital disease, ends in total atrophy of the nerve fibres, in the course of a few months or years. When due to syphilitic tumors, or other curable affections, local or systemic, the optic neuritis slowly subsides under treatment, and vision may be completely restored. More frequently, however, the disease is only checked, the vision being permanently impaired.

Treatment should be actively and persistently carried on. The underlying cause, whatever it may be, should be ascertained and the remedies best suited to its relief or cure, administered. Potassium iodide and mercury, local and general bloodletting, and, in acute cases, profuse diaphoresis should, as a rule, be employed independently of the cause.

RETRO-BULBAR OPTIC NEURITIS is manifested in two forms, acute and chronic. Acute retro-bulbar optic neuritis is caused by exposure to cold, sudden cessation of the menstrual flux, and other causes which lead to a sudden serous exudation into the vaginal sheath of the optic nerve. Total blindness follows in a few days, the result of pressure on the blood-vessels and consequent functional inactivity of the nerve fibres. The ophthalmoscope reveals a papillitis of moderate severity. The disease, if seen in time, yields to energetic and well-directed medication, that is to say, to general blood-letting, salivation, and active diaphoresis.

Chronic retro-bulbar optic neuritis, is an interstitial inflammation affecting, primarily, the axial fibres, and, secondarily, all fibres of the optic nerve. There is an hypertrophy of the connective tissue fibres, followed by atrophy of the nerve. The ophthalmoscope shows a dull, slightly hyperæmic and foggy papilla, the outline of which is in places obscured. The veins are enlarged and the arteries diminished in size.

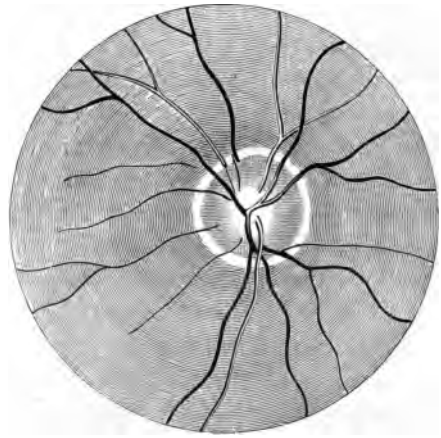
The symptoms are slowly diminishing central vision; central color perception and, later, perception for white, is lost. The patient's single complaint is loss of vision; no pain or headache is experienced. Its most common cause, is the excessive use of tobacco and alcohol, one or both. Other toxic agents, such as quinine, lead, and syphilis, cause this form of the disease.

Treatment.—In tobacco and alcohol amblyopia the causa-

tive agents must be abandoned in toto, and strychnine hypodermatically administered in increasing doses. This treatment will in most cases greatly relieve, or altogether cure, if the disease has not advanced to atrophy. Electricity is also indicated in these cases. If syphilis is the cause, iodide of potassium and mercury are the most effective remedies.

ATROPHY OF THE OPTIC NERVE (Fig 79).—Atrophy of

FIG. 79.



ATROPHIC EXCAVATION.

the optic nerve fibres is the result of an increase in the interstitial connective tissue in the intra-ocular extremity alone, or in the nerve stem from the chiasm to the ball. It is primary when the result of a neuritis, and secondary when the deep origin of the nerve is destroyed, or when the retina is the site of the original lesion. Atrophy of the intra-ocular extremity of the nerve is the result of disease of the nerve, papilla, or of the retina.

Causes.—1. Mechanical pressure from tumors, orbital cellulitis, meningitis, inflammatory exudates, traumatism, and in hydrocephalus. 2. Embolus in the central retinal artery, which cuts off the blood supply, and in this way starves the nerve. 3. Traumatic or surgical section of the nerve. 4. Disease of nerve at its periphery, the retina, or at its origin in the optic thalami and neighboring basal ganglia. 5. Gray degeneration of the optic nerve, the final stage of neuritis medullaris, in which the fibres undergo softening and destruction in one or more bundles. 6. Simple atrophy of the nerve trunk, and its intra-ocular end as a part of a similar process in the brain and spinal cord. This form is frequently associated with tabes dorsalis and cerebral sclerosis.

Ophthalmoscopic Appearances vary with the cause of the atrophy. The disc, in atrophy following papillitis, is increased in size, and the lamina cribrosa and its outline are more or less obliterated by exudation in its tissue as well as in the surrounding retina. The arterial walls are thickened and their lumen lessened; the veins may be distended and tortuous, normal, or reduced in size, and marks of old hemorrhages, and of pigment changes, are discernible around the disc. The disc, following interstitial and medullary neuritis, is discolored, its edges and centre appear veiled, and the arteries and veins, particularly the former, are small. There are no evidences of gross lesions. The disc in simple or progressive atrophy of the optic nerve, is of a dead or bluish-white, sharply outlined against the red reflex from the choroid. The lamina cribrosa is distinctly visible, the nerve cupped, arteries reduced to white threads without any appearance of capillary distribution, the veins more numerous and distinct than the arteries, but not so large or numerous as in health.

The symptoms are gradual diminution in the acuity of vision, concentric limitation of the visual field for white and colors, loss of sectors of the field, central white and color scotoma, and hemianopsia. Both eyes are usually involved, the disease advancing equally in the two eyes, or more rapidly in one than in the other.

Treatment.—Iodide of potassium, oxide of silver, bichloride of mercury and electricity.

TOBACCO AND ALCOHOL AMBLYOPIA.—In this disease, which occurs so frequently and is so amenable to treatment that it would seem to demand separate mention, the connective tissue binding together the bundles of nerve fibres becomes hypertrophied, and the nerve fibres themselves undergo fatty degeneration late in the course of the disease, either from pressure, or from the direct action of the toxic agents. The structural changes in the optic nerve trunk in case of simple tobacco amblyopia are not easily determined, because persons addicted to the excessive use of tobacco are, in a very great majority of cases, also intemperate in the use of alcohol. The symptoms and ophthalmoscopic appearances are, however, identical, whether the cause be single or dual. These changes manifest themselves in a slow deterioration of vision with central color scotoma, the peripheric field of vision for white and colors remaining unchanged until late in the progress of the disease, or until atrophic changes are well marked in the optic nerve. The disc is either normal or slightly hyperæmic, and its outline indistinct, at least in part. Later in the course of the disease, the disc presents the aspect of atrophy which follows a retro-bulbar neuritis, so that it is discolored and comparatively free from vascularity.

Unless the disease has progressed to atrophy of the optic nerve when seen, the prognosis is good, provided the

patient can abstain altogether from the use of tobacco and alcohol. Total abstinence from the use of alcohol and tobacco is a prerequisite to treatment, which consists, medicinally, in the use of strychnine. This agent should be gradually increased until maximum doses, the fifth of a grain three times daily, are reached. Local extraction of blood is valuable in patients who are not anæmic. Men are more frequently affected than women, and both eyes are usually, and equally, affected.

HEMIANOPSIA is the condition in which one-half of the field of vision is lost. It is *bilateral* when the temporal half of one and the nasal half of the other eye is lost; *bi-temporal* when the temporal, *binasal* when the nasal halves of the field are lost, and *vertical* when the dividing line is horizontal and the upper or lower field is wanting. The dividing line, vertical or horizontal, rarely passes through the point of fixation, but makes a small curve around it, thus showing that the fovea is functionating. Other sections, corresponding in each eye, may be obliterated. The ophthalmoscope reveals nothing abnormal, excepting atrophy of the optic nerve in the late stages of the disease.

Hemianopsia is caused by pressure (tumor) upon half the chiasm, optic tract, or deep origin of the nerve, or destruction of these parts from other organic changes.

PART XIV.

DISEASES OF THE ORBITAL CAVITY.

PERIOSTITIS.—The periosteal lining of the bony walls of the orbital cavity is sometimes the seat of inflammation of a chronic character, usually limited to a small area. The inflammatory process may, however, be so extensive as to involve the periosteum lining the frontal sinuses and the antrum of Highmore, and so protracted as to lead to extensive necrosis of the underlying bones. It is usually found as a local indication of syphilitic, or tuberculous disease. The local, as well as the constitutional, treatment is the same as for periostitis in other situations. The affection rarely involves the eyeball.

PHLEGMON OR ABSCESS.—From injury, thrombosis, erysipelas, etc., the supporting fat and loose connective tissue of the orbital cavity may become acutely inflamed. It is a purulent inflammation, characterized by marked œdema and increased tension of the conjunctiva and lids, which are distended forward, and by fixation of the eyeball in a straight or deviating position, and consequent double vision. It is an acutely painful affection, and should be relieved by free incisions, repeated if necessary, drainage, and by antiseptic dressings.

TUMORS OF THE ORBIT.—Cystic tumors, degeneration of the lacrymal gland, and various other forms of benign and malignant growths, are not uncommonly met with in this situation. They are easy of diagnosis. The treatment is by removal.

EXOPHTHALMUS is a bulging forward of one or both eyeballs. The protrusion of one eye is likely to be the result of local cause (abscess, injury, aneurism, etc.), and should be treated accordingly. Protrusion of both eyeballs is, on the other hand, likely to be the result of a remote or systemic cause, such as hypertrophy of the thyroid gland, or of the heart, and, under these conditions, local treatment is of no avail.

ENOPHTHALMUS is a sinking backward, or retraction in the orbital cavity, of one or both eyeballs. In senile enophthalmus, which is due to the gradual absorption of the orbital fat in old persons, both eyes are affected to the same degree. When one eye is retracted from traumatism, involving a fracture of the walls of the orbit, the resulting inflammation is severe, an abscess forms, the eyeball becomes immovable, and atrophy of the optic nerve is the ultimate consequence.

PART XV.

OPERATIONS.

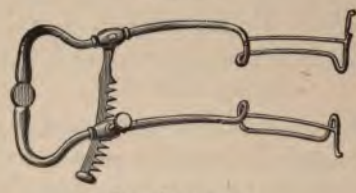
Such portions of the surgeon's person as are likely to come in contact with the patient, as well as the instruments and parts to be operated on, should be free from infection. To this end, the operator's hands should be thoroughly scrubbed with soap and hot water, and then bathed in a 1–5000 solution of the bichloride of mercury. Great care must be exercised, too, to render aseptic the conjunctival sac, the under surface of the lids, eyelashes and neighboring parts of the patient's face. The instruments should be disinfected by a 1–5000 solution of the bichloride of mercury, or, better still, by a saturated solution of boric acid. In the minor operations, as for squint, pterygium, etc., these prophylactic measures against micro-organisms, may be considered as complete when the operator's hands and instruments, and the patient's eye, have been suitably cleansed. Any coincident disease of the eye of an inflammatory character should receive the necessary attention, and the general system put in the best possible condition, before the eye is invaded by the surgeon's knife in the graver operations.

The eye is sufficiently anæsthetized by four or five instillations, at intervals of five minutes, of a four per cent. solution of the hydrochlorate of cocaine, to render all operations, except enucleation, painless. For plastic

operations on the lids, and for enucleation, ether should be employed.

CATARACT EXTRACTION WITH IRIDECTOMY.—The patient

FIG. 80.



LID SPECULUM.

is placed in a recumbent position, face up, and the eye to be operated on suitably illuminated. The speculum (Fig. 80) is then inserted or the upper lid elevated by an assistant, the

FIG. 81.

FIXATION FORCEPS.

conjunctiva of the ball grasped a few mm. below the extremity of the vertical meridian of the cornea, and gently but firmly held by fixation forceps (Fig. 81). 1. A cut is

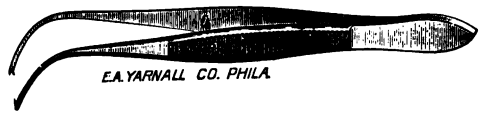
FIG. 82.

GRAEFE CATARACT KNIFE.

made through the cornea with a Graefe knife (Fig. 82), which is entered at the corneal margin just above its horizontal diameter, and a counter-puncture made exactly opposite by passing the knife through the anterior chamber in front of the

pupil. By a sawing movement of the knife with its cutting edge upward, the corneo-scleral border is divided in its upper two-fifths. When the cut is finished, the fixation forceps should be removed, at least temporarily. 2. A portion of the iris, is removed (iridectomy). When the patient is tractable, the iridectomy should be made without fixation.

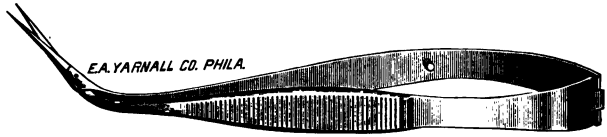
FIG. 83.



IRIS FORCEPS.

The patient is directed to look downward and to keep the eye perfectly still. The iris forceps (Fig. 83) are introduced, closed, through the centre of the incision previously made, and then opened in order to grasp a portion of the iris, near its pupillary border, which is slowly withdrawn and cut off at its periphery. To excise a large piece, as in

FIG. 84.

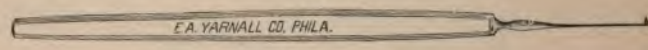


IRIDECTOMY SCISSORS.

the operation for glaucoma, the blades of the iris scissors should be held at right angles to the vertical meridian of the cornea and more than one clip made, but in the operation for cataract, they should be held in the plane of the vertical meridian, as only a small section of the iris is to be removed. 3. The anterior capsule of the lens is lacerated

(capsulotomy). A cystotome (Fig. 85) is introduced through the incision as far as the lower pupillary margin with its cutting point directed upward; one quarter revo-

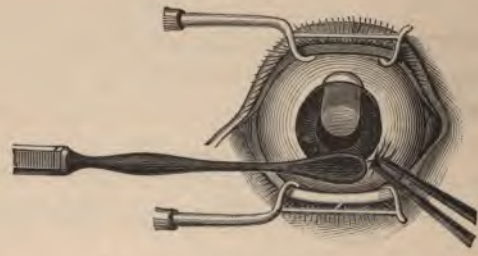
FIG. 85.



CYSTOTOME.

lution of the handle is then made, turning the point backward, and the capsule lacerated vertically and horizontally. Another quarter revolution of the handle is made, and the

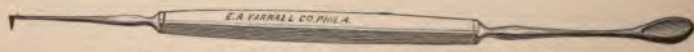
FIG. 86.



EXPULSION OF THE CATARACT.

instrument withdrawn with its point downward. The quarter revolutions prevent entanglement of the instrument in the iris and cornea on entering and withdrawing it. 4. The

FIG. 87.



GRAEFE CATARACT SPOON AND CYSTOTOME.

lens (Fig. 86) is extruded through the lacerated capsule, artificial pupil and corneal cut, by gentle and sustained pressure with the Graefe spoon (Fig. 87), or with the

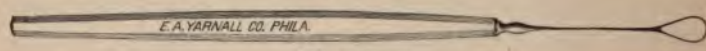
finger, on the inferior portion of the cornea and adjoining sclera, assisted by counter-pressure on the sclera above the cut. 5. The anterior chamber is freed from blood, and remaining cortical matter, by massage with the spoon, or by gentle injection of warm distilled water, or, better, by a solution of boric acid, gr. v–℥j. This may be done by means of an ordinary glass dropper, or by a syringe specially devised for the purpose.

A small pad of absorbent cotton anointed with vaseline, is applied over the closed lids of both eyes, taking care that the lashes of the lower lids are not inverted, and held in position by a roll of flannel bandage, or, preferably, by a piece of loose worsted knitted for the purpose. This dressing should remain undisturbed for twenty-four hours. At the expiration of that time, it should be removed, the eye bathed with a 1-5000 solution of the bichloride of mercury, or with a saturated solution of boric acid, and the lower lid everted to permit the escape of tears which may have collected. The eyes are again dressed, as on the preceding day, and the dressing allowed to remain for another period of twenty-four hours, when the treatment is repeated. On the third day after the operation, the eye not operated on may be left unbandaged. On the fifth day, the cut may be inspected. Up to the fifth day, the patient should remain in bed, resting on the back as much as possible. This plan of treatment should be closely followed in cases that run a normal course. If, however, severe pain in the eye, or in the adjoining parts, develops, indicating iritis, or if a discharge of mucus or pus is noticed on the cotton when the dressing is changed, the eye must be examined, and appropriate remedies applied, such as atropine instillations, the constant application of a saturated solution of boric acid by means of absorbent cotton, and leeches

applied to the temple, together with the internal administration of potassium iodide and mercury.

In this operation, certain complications are likely to arise. First, the corneal cut may not be sufficiently large to admit of the easy escape of the lens; second, if there is prolapse of the iris in the corners of the wound, it must be replaced by gentle manipulation; third, if the view of the pupil is

FIG. 88.



WIRE LOOP.

obstructed by a collection of blood in the anterior chamber, it should be expelled through the open wound by gentle and repeated upward pressure on the cornea with the spoon; fourth, if the capsulotomy is too small to admit of the passage of the lens, the cystotome should be reintroduced and a more complete division of the capsule made; fifth, if a bead of vitreous presents at the corneal incision

FIG. 89.

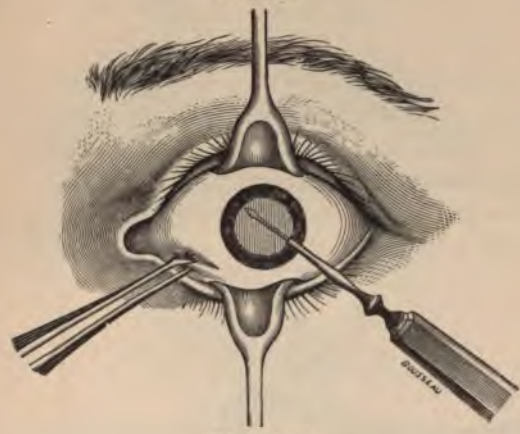
LENS EXTRACTOR.

before the extraction of the lens, the speculum must be withdrawn, and the lens removed by means of the loop or extractor (Figs. 88 and 89).

CATARACT EXTRACTION WITHOUT IRIDECTOMY.—A Graefe knife is used, and the incision includes five-twelfths of the corneo-scleral margin. The cut is made through the cornea at its junction with the sclera, and a conjunctival flap avoided.

An extensive division of the lens capsule is next made with a Knapp knife, especially designed for that purpose, which is passed under the iris vertically and horizontally, and after division of the capsule slow, steady, and continuous pressure with the spoon on the lowest part of the cornea expels the lens. If the iris prolapses, it must be replaced. Eserine, gr. j–℥j, is dropped into the eye, which is otherwise treated as in the preceding modified Graefe operation, before it is bandaged.

FIG. 90.



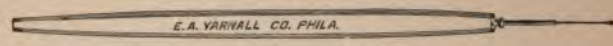
DISCISSION.

This operation is both difficult and dangerous. The advantages claimed for it are the avoidance of iritis, which sometimes follows iridectomy, the round pupil, and better vision. The dangers to be considered are a prolapse of the iris, and a difficult technique, especially in the performance of the capsulotomy.

SOFT CATARACT.—Discission (Fig. 90) is the generally accepted operation for soft cataract. A stop needle (Fig.

91) is passed through the anæsthetized cornea into the dilated pupil, the capsule freely divided and the lens broken up by gentle movements of the needle point in its substance. The moderate reaction which follows this operation is controlled by frequent instillations of atropine, gr. viij–℥j. If the reaction is severe, the lens greatly swollen and the iris

FIG. 91.

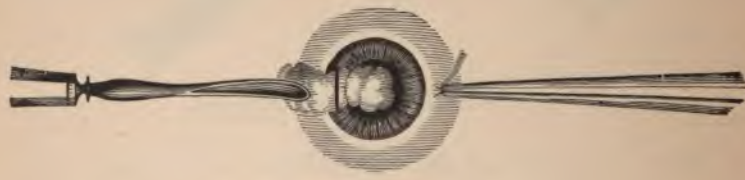


SOFT CATARACT NEEDLE.

bellied forward with large sections of the lens floating in the anterior chamber, an incision with the Graefe or iridectomy knife should be made through the cornea, and the offending masses gently pressed out (Fig. 92).

IRIDECTOMY is performed (Fig. 93) in glaucoma to lessen tension and to establish drainage from the eye, in cataract

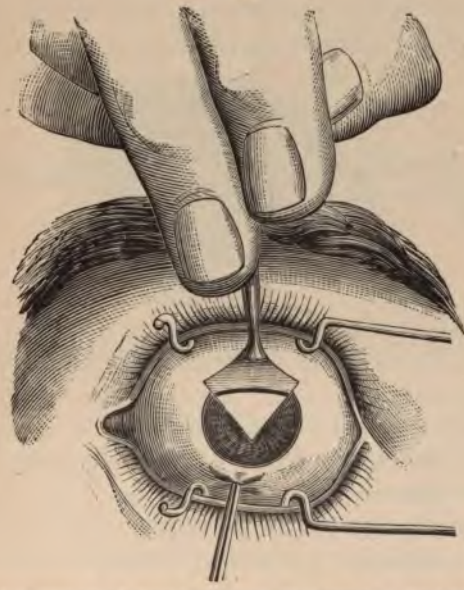
FIG. 92.



extraction, lamellar cataract, in the removal of foreign bodies from the anterior chamber, in complete annular synechiæ, and for optical purposes. The eye to be operated on, is held as in the operation for cataract extraction, and an incision made with the lance knife (Fig. 93) in the corneo-scleral border. The point of the knife is passed into the anterior

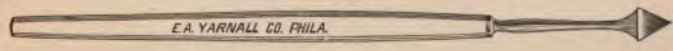
chamber, in front of and parallel with the plane of the iris, to the necessary depth. In withdrawing the knife, its handle is tilted backward to prevent too rapid escape of the aqueous

FIG. 93.



LINEAR INCISION AT THE SUPERIOR MARGIN OF THE CORNEA.

FIG. 94.



IRIDECTOMY KNIFE.

humor and prolapse of the iris. The next step, without fixation when possible, is to introduce the forceps and grasp the iris, which is then withdrawn and excised in the manner

already described in the operation for cataract. Finally, the angles of the pupil should be replaced, and the margins of the wound carefully approximated. The eye should be dressed as described in the operation for cataract extraction. At the expiration of twenty-four hours the wound

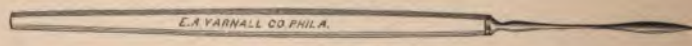
FIG. 95.

ARTIFICIAL PUPIL AS SEEN IN ANTERIOR CHAMBER AFTER IRIDECTOMY.

will have healed with re-establishment of the anterior chamber. The bandage may be discarded in three days and a shade substituted.

IRIDOTOMY or IRITOMY is necessary when the pupil, as a result of traumatism or cataract extraction, is occluded by

FIG. 96.

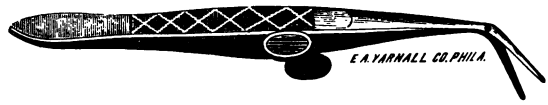


IRIDOTOMY KNIFE.

thickened and opaque capsule with inflammatory exudations from the iris. A needle-knife (Fig. 96) with double cutting edge, so constructed that its shank completely fills the corneal wound, thus preventing the escape of the aqueous, is thrust through the cornea midway between its centre

and periphery and into the occluding membrane, which is divided at right angles to the line of greatest tension. Scissors (Fig. 97) devised by De Wecker are sometimes successfully used in this operation. With the lance knife, a small wound is made between the centre and circumference of the cornea, the blade is then slowly withdrawn half way, allowing the aqueous, which carries the iris forward with it, to partly

FIG. 97.

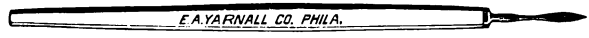


DE WECKER'S IRITOMY SCISSORS.

escape. The knife is then thrust through the iris and withdrawn. De Wecker's scissors are entered closed, opened in the anterior chamber, and one blade passed through the cut in the iris. Both blades are made to meet through the iris, thus elongating the incision made by the knife.

PARACENTESIS CORNEA consists in perforating the cornea with a small, double-edge knife (Fig. 98). The object of

FIG. 98.



PARACENTESIS KNIFE.

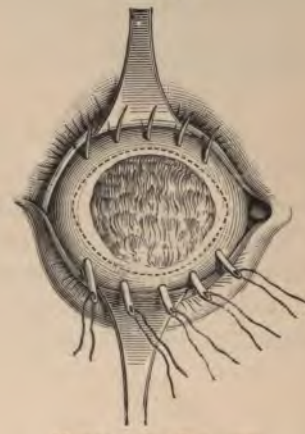
the operation is to reduce intra-ocular pressure by emptying the anterior chamber.

SÆMISCH INCISION is sometimes resorted to for the purpose of obviating the worst effects of corneal abscess. The clear cornea immediately surrounding the abscess is penetrated by a Graefe knife, which is passed through the

anterior chamber to a corresponding point in the clear cornea on the distal side of the abscess, dividing it in its long diameter. This procedure drains the abscess and union is promoted by the expulsion of the pus.

Conical Cornea.—The operation for this condition, consists in excision of the cone, wholly or in part, by a Graefe knife, and bringing the divided edges together by sutures. Exceedingly fine needles armed by a single strand of silk are

Fig. 99.

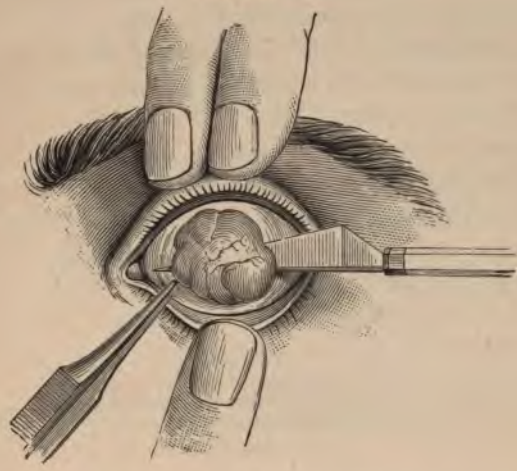


Needles in Position.

necessarily used in thus suturing the edges of the wound. The resulting cicatrix is, perhaps, less detrimental to vision than the previously existing cone.

Staphyloma of Cornea and Sclera (Figs. 99, 100, 101).—Critchett's operation is to be preferred to enucleation in children, as the parts of the ball remaining in the orbit will prevent unsymmetrical development of the bones of the

FIG. 100.



EXCISION OF THE STAPHYLOMA.

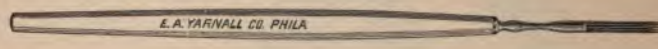
FIG. 101.

APPEARANCE OF THE STUMP AFTER EXCISION OF THE STAPHYLOMA.

face, the invariable result of enucleation in children. The operation is simple and effective. Four threaded needles are inserted equi-distant and parallel with each other through the base of the staphyloma, the diseased tissues are then removed with a knife or scissors, the needles drawn through, and each thread tied.

Corneal Tattooing, which has for its object the substitution of a black and invisible for a white and disfiguring opacity of the cornea, is effected by several fine steel points or needles firmly fastened in a handle (Fig. 102). The points are dipped in a solution of india ink, and the corneal

Fig. 102.



opacity gently punctured. If the opacity is large, several sittings are necessary in order to avoid the dangerous reaction of a prolonged, or too extensive operation.

FOREIGN BODIES.

A. *In Conjunctiva.*—To inspect the lower cul-de-sac, the patient is directed to look upward while the lower lid is drawn down and away from the ball. The upper cul-de-sac is revealed by inverting the upper lid, and having the patient look downward. A foreign body when seen in either of these situations, is easily removed by a small spud, or by a pledget of cotton wound on the end of a match stick.

B. *In Cornea.*—Before attempting to remove foreign bodies in this situation, anæsthesia of the part should be induced by a single instillation of a four per cent. solution

of cocaine. The body is then lifted or removed from its position by a spud (Fig. 103), or other suitable instrument.

C. *In Anterior Chamber.*—If the body is iron or steel, its removal may be accomplished, through a proper opening in the cornea, by means of a magnet. In the absence of a magnet, or when it is ineffective, that part of the iris on which the foreign body rests should be drawn out and cut off. It is a dangerous and often impracticable proceeding to attempt the extraction of a body thus placed, without simultaneously performing an iridectomy.

D. *In Lens.*—The presence of a foreign body in the lens, such as a fragment of metal may be early recognized with the ophthalmoscope or oblique illumination, by its lustre. If it has passed through the lens, its path

FIG. 103.

will be marked by a streak of gray opacity. In either case a cataract develops which must be, when sufficiently advanced, extracted. That procedure should be selected which, in case the lens contains the body, insures its extraction, since enucleation will, in most cases, be necessary eventually, if the foreign body is dislodged into the vitreous chamber.

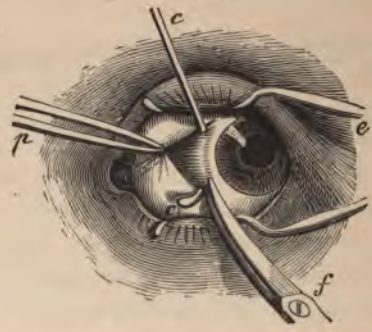
E. *In Vitreous Chamber.*—Extraction of the body by the magnet should be attempted. Enucleation of the ball, in order to prevent sympathetic involvement of the unaffected eye is, however, usually necessary.

TENOTOMY (Figs. 104 and 105). The conjunctiva and capsule of Tenon are grasped by forceps over the insertion of the tendon, and divided at right angles to the line of its

FIG. 104.

INCISION OF THE CONJUNCTIVA.

FIG. 105.



SECTION OF THE TENDINOUS INSERTION.

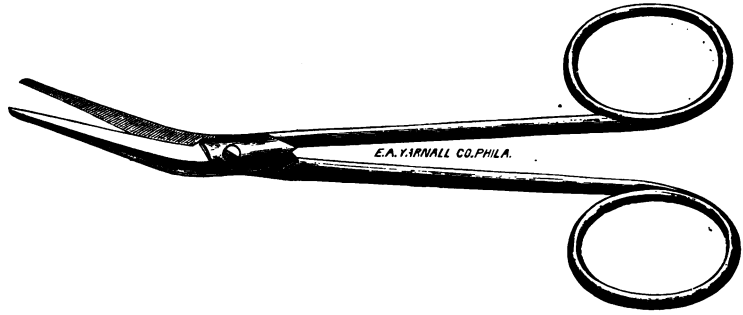
FIG. 106.

STRABISMUS HOOK.

attachment. A tenotomy hook (Fig. 106) is passed under the tendon, which is elevated from the surrounding parts, and drawn into view. The tendinous expansion of the muscle at its attachment to the sclera, thus brought into view, is divided by several clips with blunt-pointed scissors (Fig. 107).

GRADED or PARTIAL TENOTOMY consists in making an incision, not exceeding 2 mm., through the conjunctiva and capsule of Tenon, as described in the foregoing opera-

FIG. 107.



CONJUNCTIVAL SCISSORS.

tion for tenotomy, and passing a small hook (Stephen's) under the tendon, which is carefully separated from the sclera in its central attachment. The extent to which the tendinous division of the muscle is carried is proportionate to the effect desired. In practice, it will be found that no lessening of the muscular power, as determined by prisms, is obtained until the tendon is nearly, if not completely, divided. In this operation, therefore, the cut through the conjunctiva and capsule is smaller and the spreading, lateral fibres of the tendon are not divided.

ADVANCEMENT OF A TENDON.—The enveloping tissues, conjunctiva and capsule of Tenon, are dissected until the muscle and tendon to be operated on are brought clearly into view, and a needle armed with silk, not too fine, is passed through the muscle at right angles to its course, and carried first through the conjunctiva above and then below, the cornea. The muscle is next divided in front of the suture, and the thread drawn firmly and tied. The effect of the operation will be increased by excising a small portion of the conjunctiva and capsule, between the insertion of the tendon and the cornea. The surgeon should be careful to pass the needle through the capsule as well as conjunctiva, otherwise the thread will in a few hours cut its way out, and thus aggravate the symptoms the operation is designed to relieve. The sutures should be removed on the fourth or fifth day.

Tenotomies and partial tenotomies are, of course, to be performed upon any of the recti muscles that may be at fault.

PTERYGIUM.—The old and unsatisfactory operation of abscission has been abandoned in favor of transplantation, a simple and more effective method of treatment. The edges of the pterygium are grasped, brought together and the whole mass elevated by fixation forceps. A strabismus hook is passed under the pterygium at the site of fixation by rupturing the two lateral folds of adherent conjunctiva, and its apex detached from the cornea by a sudden movement or jerk of the hook in the direction of the cornea. (No operation is advisable until the growth has invaded the cornea.) The detached apex is transfixed by a thread armed at both ends with a needle, and the two needles are carried a considerable distance under the conjunctiva to a point obliquely above or below the base of the growth, and passed out a few mm. from each other. The threads

are made taut, drawing the apex of the pterygium upward or downward under the conjunctiva, and tied. The pterygium is in this way transplanted and allowed to grow without subsequent disturbance to vision, or other annoyance to the patient. The traumatic ulcer of the cornea, made by tearing off the hypertrophied growth, heals rapidly, leaving as a rule a nearly invisible opacity, which may be disregarded. The thread is removed on the fifth day.

ENUCLEATION.—The patient is placed in recumbent position, anæsthetized and the parts thoroughly disinfected. The globe is exposed as much as possible by the introduction of a speculum, the arms of which are held widely separated. The surgeon grasps the conjunctiva adjacent to the inner extremity of the horizontal diameter of the cornea, and divides it circularly one or two mm. from the corneoscleral border. This incision of the conjunctiva, which extends two-thirds around the circumference of the cornea, is made in two equally divided cuts, the first below and the second above, from the point of fixation. The separated conjunctiva and capsule of Tenon are pushed back with the fixation forceps or closed scissors, and the tendon of the internal rectus grasped, divided posterior to the forceps, and held until the operation is finished. One blade of the straight conjunctival scissors is passed beneath the inferior rectus and the two blades brought together, dividing the muscle. The superior rectus is divided in a similar manner. The enucleation scissors (Fig. 108) are now passed backward, with the points closed and hugging the sclera until the optic nerve is reached, which is then divided. The ball is now easily rotated outward and as it turns every tissue clinging to the sclera is divided and left in the orbit. Hemorrhage is checked by pads of absorbent cotton, con-

fined by a roller bandage, which is drawn tight enough to exercise a moderate degree of pressure. This dressing is not changed for twenty-four hours. At the expiration of that time it is removed, the parts cleansed with a bichloride wash, and a new dressing of a similar kind applied. The bandage may be discarded on the third or fourth day, and a saturated solution of boric acid given the patient with instruction to bathe the orbit two or three times a day until the wound is entirely healed. As a rule, an artificial eye may be worn after the lapse of four weeks.

SYMBLEPHARON.—If the band holding the ball and the lid

FIG. 108.

ENUCLEATION SCISSORS.

together is narrow, it may be separated by an enveloping lead ligature, tightly twisted, which is allowed to cut its way through. When this is accomplished the ocular extremity of the adhesion is removed and the part sutured (Fig. 109). When the adhesion is broad it is separated, under tension, from its ocular attachment by the knife or scissors. A thread armed with two needles is passed through the divided end of the cicatricial tissue. The needles are carried from the bottom of the cul-de-sac from within outward through the lid, the thread drawn tight over a small pad and tied, and the divided ocular conjunctiva sutured (Fig. 110).

ANKYLOBLEPHARON.—The adhesions must be separated by knife or scissors, having first ascertained their extent

FIG. 109.

OPERATION FOR SYMBLEPHARON BY THE INTRODUCTION OF A LEADEN THREAD.

FIG. 110.

ARLT'S METHOD.

by passing a probe, and the lids kept apart by traction during the healing process.

CANTHOTOMY.—The temporary widening of the palpebral commissure, consists in introducing one blade of the enucleation scissors into the conjunctival sac at the outer angle of the commissure and carrying it toward the temporal side until it has reached the margin of the orbit, and then bringing the two blades of the scissors together, dividing skin, fat, orbicularis muscle, subconjunctival connective

FIG. 111.

CANTHOPLASTY.

tissue and the conjunctiva. This operation is of great benefit in chronic catarrhal conjunctivitis with corneal ulcer.

CANTHOPLASTY (Fig. 111).—The object of this operation is to permanently widen the palpebral commissure. The tissues are divided, as in the operation of canthotomy just described, by a single cut with the scissors, and the raw margins of the divided skin and conjunctiva brought together by three sutures, the first uniting the parts in the angle of

the cut, the second and third sutures uniting them on the lower and upper lid in the order named.

TARSORRAPHY (Fig. 112) is the operation for shortening,

FIG. 112.

TARSORRAPHIA.

FIG. 113.

HORN PLATE.

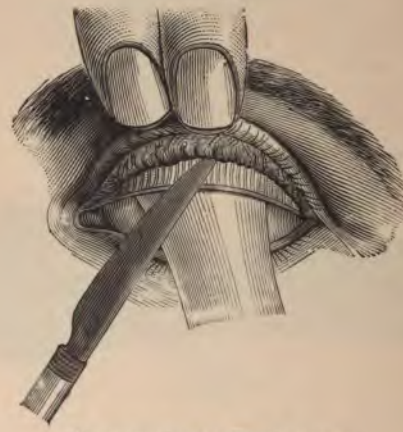
FIG. 114.

LID FORCEPS.

or altogether closing the palpebral aperture. It consists in stretching the upper lid over a horn plate (Fig. 113) or lid forceps (Fig. 114), and removing with a small iridectomy

knife a flap, 1 mm. broad from its free margin, the desired distance toward the outer canthus, *a b* Fig. 112, including the hair bulbs. The excision is extended 2–3 mm. over the inner border, in order to insure close union of the parts in exact juxtaposition. The lower lid is similarly treated and the raw surfaces of the two lids are brought together by fine sutures. The eye is bandaged and kept shut until the wound unites; the sutures are then removed.

FIG. 115.



OPERATION FOR DISTICHIASIS.

EXCISION OF CILIÆ (Fig. 115) is sometimes performed for the relief of distichiasis. The operation is simple, and usually effective. The lid is elevated by a horn or lid forceps, and an incision 2 mm. deep made between the tarsus and skin in the edge of the lid from one canthus to the other. A second incision of the same length is made through the skin 2 mm. from the border down to the tarsus. The portion of skin and fascia thus separated and

removed, should include the bulbs of the ciliæ, but not the meibomian glands. Suturing is not necessary.

ENTROPION.—The skin overlying the centre of the upper border of the tarsus is nicked and lid forceps inserted. Commencing at the indentation thus made and passing horizontally right and left, the upper half of the cartilage is cleared its entire width by division of the skin, connective tissue and muscle which, after division, are pushed toward the ciliary border. A suture is passed from below upward through the pad of tissues thus formed, and carried through the upper border of the exposed cartilage. Fixation forceps, held in the left hand, are now thrust backward and upward to grasp the relaxed levator palpebræ tendon, which is drawn forward. Finally, the needle is thrust through the tendon thus advanced, and the two ends of the thread tied. Two lateral sutures, one at either side of the first, are carried through the mass, in a similar manner, and tied.

ECTROPION (Figs. 116 and 117).—In eversion of the lid, some form of plastic operation is usually necessary. As a rule, a V-shaped excision of a part of the lid is made, and skin from below brought in its place and held by sutures. Occasionally it will be found sufficient to cauterize with a hot iron the everted conjunctiva, which will slough and leave a cicatrix extensive enough to maintain the lid in its proper position. Or, instead of the hot iron cautery, caustics may be employed to destroy the indurated and hypertophied conjunctiva, and to form the necessary cicatrix.

CHALAZION.—The removal of these bodies is the same as for cysts in other situations of the body. A chalazion can readily be dissected out from the conjunctival surface as a rule, and when practicable this surface should, for

obvious reasons, be selected. The lid is secured by forceps, the cyst incised, emptied, and an obliterative inflammation

FIG. 116.

OPERATION FOR ECTROPION: THE INCISION.

FIG. 117.

OPERATION FOR ECTROPION: THE SUTURES IN POSITION.

of its walls induced by the application of the solid stick of silver nitrate, or by crystals of copper sulphate. Under this

treatment, all signs of the tumor, and of the consequent inflammation, disappear.

PTOSIS.—The simplest and most effective operation, consists in passing a stout silk ligature vertically under the skin from the eyebrows to the margin of the lids, and firmly tying the ends. The noose thus formed is daily tightened until it has cut its way through the confined tissues. The resulting cicatrix restores and holds the lid in its normal position.

STRICTURE OF THE LACRYMAL DUCT.—The lower lid is made tense and the point of a Weber Knife (Fig. 118) introduced vertically into the punctum, its handle lowered until it is brought into a horizontal position, and the blade

FIG. 118.

CANALICULUS KNIFE.

of the instrument with its cutting edge upward, thrust forward until it comes in contact with the lacrymal bone. The handle is again elevated to a point immediately in front of the supra-orbital notch, and a cut made along the inner and free margin of the lid, converting the canaliculus into a gutter. The point of the knife with its cutting edge forward, is now engaged in the lacrymal sac, whence it is carried downward, backward and slightly outward into the nasal duct, dividing the stricture.

The canal thus re-established (Fig. 119) should be maintained for a time by the daily introduction of a probe, No. 10, Bowman (Fig. 120). After the lapse of a week or ten days, No. 8 or 6 probe may be used, and the intervals

FIG. 119.

PROBING THE NASAL DUCT.

FIG. 120.

of its introduction gradually increased until all signs of obstruction have subsided.

Various operations for epithelioma, ulcer, nævi, warty excrescences, etc., have been suggested. They belong, however, to the domain of general surgery. The ingenuity of the operator and his knowledge of the principles of general surgery, must be relied upon to devise proper measures for their relief.

An operating case suitable for operations described in this volume would contain—

Graefe Knife, straight Keratome, bent Keratome, Graefe Cystotome, Small Strabismus Hook, Bowman's Stop Needle, Speculum, Double Scoop, Canaliculus Knife, Curved Iris Forceps, Fixation Forceps, Ciliæ Forceps, McClure's Iris Scissors, Enucleation Scissors, Conjunctival Scissors, Lid Retractor, Set of Bowman's Probes, Lid Forceps, Horn Plate, Spud, Lens Extractor, Needle Holder, Needles and Silk. Cost, about $35.00.

INDEX.

N.

O.

P.

R.

S.

T.

CATALOGUE No. 7. OCTOBER, 1892.

A CATALOGUE

OF

BOOKS FOR STUDENTS.

INCLUDING THE

? QUIZ-COMPENDS ?

CONTENTS.

PUBLISHED BY

P. BLAKISTON, SON & CO.,

Medical Booksellers, Importers and Publishers.

LARGE STOCK OF ALL STUDENTS' BOOKS, AT

THE LOWEST PRICES.

1012 Walnut Street, Philadelphia.

*** For sale by all Booksellers, or any book will be sent by mail, postpaid, upon receipt of price. Catalogues of books on all branches of Medicine, Dentistry, Pharmacy, etc., supplied upon application.

"An excellent Series of Manuals."—*Archives of Gynæcology.*

A NEW SERIES OF
STUDENTS' MANUALS

On the various Branches of Medicine and Surgery.

Can be used by Students of any College.

Price of each, Handsome Cloth, $3.00. Full Leather, $3.50

The object of this series is to furnish good manuals for the medical student, that will strike the medium between the compend on one hand and the prolix text-book on the other—to contain all that is necessary for the student, without embarrassing him with a flood of theory and involved statements. They have been prepared by well-known men, who have had large experience as teachers and writers, and who are, therefore, well informed as to the needs of the student.

Their mechanical execution is of the best—good type and paper, handsomely illustrated whenever illustrations are of use, and strongly bound in uniform style.

Each book is sold separately at a remarkably low price, and the immediate success of several of the volumes shows that the series has met with popular favor.

No. 1. SURGERY. 318 Illustrations.
Third Edition.

A Manual of the Practice of Surgery. By WM. J. WALSHAM, M.D., Asst. Surg. to, and Demonstrator of Surg. in, St. Bartholomew's Hospital, London, etc. 318 Illustrations.

Presents the introductory facts in Surgery in clear, precise language, and contains all the latest advances in Pathology, Antiseptics, etc.

"It aims to occupy a position midway between the pretentious manual and the cumbersome System of Surgery, and its general character may be summed up in one word—practical."—*The Medical Bulletin.*

"Walsham, besides being an excellent surgeon, is a teacher in its best sense, and having had very great experience in the preparation of candidates for examination, and their subsequent professional career, may be relied upon to have carried out his work successfully. Without following out in detail his arrangement, which is excellent, we can at once say that his book is an embodiment of modern ideas neatly strung together, with an amount of careful organization well suited to the candidate, and, indeed, to the practitioner."—*British Medical Journal.*

Price of each Book, Cloth, $3.00; Leather, $3.50.

No. 2. DISEASES OF WOMEN. 150 Illus.
NEW EDITION.

The Diseases of Women. Including Diseases of the Bladder and Urethra. By DR. F. WINCKEL, Professor of Gynæcology and Director of the Royal University Clinic for Women, in Munich. Second Edition. Revised and Edited by **Theophilus Parvin**, M.D., Professor of Obstetrics and Diseases of Women and Children in Jefferson Medical College. 150 Engravings, most of which are original.

"The book will be a valuable one to physicians, and a safe and satisfactory one to put into the hands of students. It is issued in a neat and attractive form, and at a very reasonable price."—*Boston Medical and Surgical Journal.*

No. 3. OBSTETRICS. 227 Illustrations.

A Manual of Midwifery. By ALFRED LEWIS GALABIN, M.A., M.D., Obstetric Physician and Lecturer on Midwifery and the Diseases of Women at Guy's Hospital, London; Examiner in Midwifery to the Conjoint Examining Board of England, etc. With 227 Illus.

"This manual is one we can strongly recommend to all who desire to study the science as well as the practice of midwifery. Students at the present time not only are expected to know the principles of diagnosis, and the treatment of the various emergencies and complications that occur in the practice of midwifery, but find that the tendency is for examiners to ask more questions relating to the science of the subject than was the custom a few years ago. * * * The general standard of the manual is high; and wherever the science and practice of midwifery are well taught it will be regarded as one of the most important text-books on the subject."—*London Practitioner.*

No. 4. PHYSIOLOGY. Fifth Edition.
321 ILLUSTRATIONS AND A GLOSSARY.

A Manual of Physiology. By GERALD F. YEO, M.D., F.R.C S., Professor of Physiology in King's College, London. 321 Illustrations and a Glossary of Terms. Fifth American from last English Edition, revised and improved. 758 pages.

This volume was specially prepared to furnish students with a new text-book of Physiology, elementary so far as to avoid theories which have not borne the test of time and such details of methods as are unnecessary for students in our medical colleges.

"The brief examination I have given it was so favorable that I placed it in the list of text-books recommended in the circular of the University Medical College."—*Prof. Lewis A. Stimson*, M.D., *37 East 33d Street, New York.*

Price of each Book, Cloth, $3.00; Leather, $3.50.

No. 5. DISEASES OF CHILDREN.

SECOND EDITION.

A Manual. By J. F. GOODHART, M.D., Phys. to the Evelina Hospital for Children; Asst. Phys. to Guy's Hospital, London. Second American Edition. Edited and Rearranged by LOUIS STARR, M.D., Clinical Prof. of Dis. of Children in the Hospital of the Univ. of Pennsylvania, and Physician to the Children's Hospital, Phila. Containing many new Prescriptions, a list of over 50 Formulæ, conforming to the U. S. Pharmacopœia, and Directions for making Artificial Human Milk, for the Artificial Digestion of Milk, etc. Illus.

"The author has avoided the not uncommon error of writing a book on general medicine and labeling it 'Diseases of Children,' but has steadily kept in view the diseases which seemed to be incidental to childhood, or such points in disease as appear to be so peculiar to or pronounced in children as to justify insistence upon them. * * * A safe and reliable guide, and in many ways admirably adapted to the wants of the student and practitioner."—*American Journal of Medical Science.*

No. 6. MATERIA MEDICA, PHARMACY, PHARMACOLOGY, AND THERAPEUTICS.

JUST READY.

A Handbook for Students. By WM. HALE WHITE, M.D., F.R.C.P., etc., Physician to, and Lecturer on Materia Medica, Guy's Hospital; Examiner in Materia Medica, Royal College of Physicians, London, etc. American Edition. Revised by REYNOLD W. WILCOX, M.A., M.D., Prof. of Clinical Medicine at the New York Post-Graduate Medical School and Hospital; Assistant Visiting Physician Bellevue Hospital. 580 pages.

In preparing this book, the wants of the medical student of to-day have been constantly kept in view. The division into several subjects, which are all arranged in a systematic, practical manner, will be found of great help in mastering the whole. The work of the editor has been mainly in the line of adapting the book to the use of American students; at the same time, however, he has added much new material. Dr. Wilcox's long experience in teaching and writing on therapeutical subjects particularly fits him for the position of editor, and the double authorship has resulted in making a very complete handbook, containing much minor useful information that if prepared by one man might have been overlooked.

Price of each Book, Cloth, $3.00; Leather, $3.50.

No. 7. MEDICAL JURISPRUDENCE AND TOXICOLOGY.

THIRD REVISED EDITION.

By JOHN J. REESE, M.D., Professor of Medical Jurisprudence and Toxicology in the University of Pennsylvania; President of the Medical Jurisprudence Society of Phila.; Third Edition, Revised and Enlarged.

"This admirable text-book."—*Amer. Jour. of Med. Sciences.*

"We lay this volume aside, after a careful perusal of its pages, with the profound impression that it should be in the hands of every doctor and lawyer. It fully meets the wants of all students. . . . . He has succeeded in admirably condensing into a handy volume all the essential points."—*Cincinnati Lancet and Clinic.*

"The book before us will, we think, be found to answer the expectations of the student or practitioner seeking a manual of jurisprudence, and the call for a second edition is a flattering testimony to the value of the author's present effort. The medical portion of this volume seems to be uniformly excellent, leaving little for adverse criticism. The information on the subject matter treated has been carefully compiled, in accordance with recent knowledge. The toxicological portion appears specially excellent. Of that portion of the work treating of the legal relations of the practitioner and medical witness, we can express a generally favorable verdict."—*Physician and Surgeon, Ann Arbor, Mich.*

No. 8. DISEASES OF THE EYE. 176 Illus.

FOURTH EDITION. JUST READY.

Diseases of the Eye and their Treatment. A Handbook for Physicians and Students. By HENRY R. SWANZY, A.M., M.B., F.R.C.S.I., Surgeon to the National Eye and Ear Infirmary; Ophthalmic Surgeon to the Adelaide Hospital, Dublin; Examiner in Ophthalmic Surgery in the Royal University of Ireland. Fourth Edition, Thoroughly Revised. 176 Illustrations and a Zephyr Test Plate. 500 pages.

"Mr. Swanzy has succeeded in producing the most intellectually conceived and thoroughly executed *resumé* of the science within the limits he has assigned himself. As a 'students' handbook,' small in size and moderate in price, it can hardly be equaled."—*Medical News.*

"A full, clear, and comprehensive statement of Eye Diseases and their treatment, practical and thorough, and we feel fully justified in commending it to our readers. It is written in a clear and forcible style, presenting in a condensed yet comprehensive form current and modern information that will prove alike beneficial to the student and general practitioner."—*Southern Practitioner.*

Price of each Book, Cloth, $3.00; Leather, $3.50.

ANATOMY.

Morris' New Text-Book on Anatomy. 600 Specially Engraved Illustrations, many of which are printed in colors. Edited by Henry Morris, F.R C.S., and contributed to by many well-known writers. Octavo. *Nearly Ready.* Price about 6.00

*** Send for Descriptive Circular and Sample Pages.

Macalister's Human Anatomy. 816 Illustrations. A new Text-book for Students and Practitioners, Systematic and Topographical, including the Embryology, Histology, and Morphology of Man. With special reference to **the requirements of Practical Surgery and Medicine.** With 816 Illustrations, 400 of which are original. Octavo. Cloth, 7.50; Leather, 8.50

Ballou's Veterinary Anatomy and Physiology. Illustrated. By Wm. R. Ballou, M.D., Professor of Equine Anatomy at New York College of Veterinary Surgeons. 29 graphic Illustrations. 12mo. Cloth, 1.00; Interleaved for notes, 1.25

Holden's Anatomy. A manual of Dissection of the Human Body. Fifth Edition. Enlarged, with Marginal References and over 200 Illustrations. Octavo.

Bound in Oilcloth, for the Dissecting Room, $4.50.

Holden's Human Osteology. Comprising a Description of the Bones, with Colored Delineations of the Attachments of the Muscles. The General and Microscopical Structure of Bone and its Development. With Lithographic Plates and Numerous Illustrations. Seventh Edition. 8vo. Cloth, 6.00

Holden's Landmarks, Medical and Surgical. 4th ed. Clo., 1.25

Potter's Compend of Anatomy. Fifth Edition. Enlarged. 16 Lithographic Plates. 117 Illustrations. *See Page 14.*
Cloth, 1.00; Interleaved for Notes, 1.25

CHEMISTRY.

Bartley's Medical Chemistry. Second Edition. A text-book prepared specially for Medical, Pharmaceutical, and Dental Students. With 50 Illustrations, Plate of Absorption Spectra and Glossary of Chemical Terms. Revised and Enlarged. Cloth, 2.50

Trimble. Practical and Analytical Chemistry. A Course in Chemical Analysis, by Henry Trimble, Prof. of Analytical Chemistry in the Phila. College of Pharmacy. Illustrated. Fourth Edition, Enlarged. 8vo. Cloth, 1.50

Bloxam's Chemistry, Inorganic and Organic, with Experiments. Seventh Edition. 281 Illustrations. Cloth, 4.50; Leather, 5.50

☞ *See pages 2 to 5 for list of Students' Manuals.*

Chemistry:—Continued.

Richter's Inorganic Chemistry. Third American, from Fifth German Edition. Translated by Prof. Edgar F. Smith, PH.D. 89 Wood Engravings and Colored Plate of Spectra. Cloth, 2.00

Richter's Organic Chemistry, or Chemistry of the Carbon Compounds. Illustrated. Second Edition. Cloth, 4.50

Symonds. Manual of Chemistry, for the special use of Medical Students. By BRANDRETH SYMONDS, A.M., M.D., Asst. Physician Roosevelt Hospital, Out-Patient Department; Attending Physician Northwestern Dispensary, New York. Cloth, 2.00

Leffmann's Compend of Chemistry. Inorganic and Organic. Including Urinary Analysis. Third Edition. Revised.
See page 15. Cloth, 1.00; Interleaved for Notes, 1.25

Leffmann and Beam. Progressive Exercises in Practical Chemistry. 12mo. Illustrated. Cloth, 1.00

Müter. Practical and Analytical Chemistry. Fourth Edition. Revised, to meet the requirements of American Medical Colleges, by Prof. C. C. Hamilton. Illustrated. Cloth, 2.00

Holland. The Urine, Common Poisons, and Milk Analysis, Chemical and Microscopical. For Laboratory Use. Fourth Edition, Enlarged. Illustrated. Cloth, 1.00

Van Nüys. Urine Analysis. Illus. Cloth, 2.00

CHILDREN.

Goodhart and Starr. The Diseases of Children. Second Edition. By J. F. Goodhart, M.D., Physician to the Evelina Hospital for Children; Assistant Physician to Guy's Hospital, London. Revised and Edited by Louis Starr, M.D., Clinical Professor of Diseases of Children in the Hospital of the University of Pennsylvania; Physician to the Children's Hospital, Philadelphia. Containing many Prescriptions and Formulæ, conforming to the U. S. Pharmacopœia, Directions for making Artificial Human Milk, for the Artificial Digestion of Milk, etc. Illustrated. Cloth, 3.00; Leather, 3.50

Hatfield. Diseases of Children. By M. P. Hatfield, M.D., Professor of Diseases of Children, Chicago Medical College. Colored Plate. 12mo. Cloth, 1.00; Interleaved, 1.25

Starr. Diseases of the Digestive Organs in Infancy and Childhood. With chapters on the Investigation of Disease, and on the General Management of Children. By Louis Starr, M.D., Clinical Professor of Diseases of Children in the University of Pennsylvania. Illus. Second Edition. Cloth, 2.25

☞ *See pages 14 and 15 for list of "Quiz-Compends"*

DENTISTRY.

Fillebrown. Operative Dentistry. 330 Illus. Cloth, 2.50

Flagg's Plastics and Plastic Filling. 4th Ed. Cloth, 4.00

Gorgas. Dental Medicine. Fourth Edition. Cloth, 3.50

Harris. Principles and Practice of Dentistry. Including Anatomy, Physiology, Pathology, Therapeutics, Dental Surgery and Mechanism. Twelfth Edition. Revised and enlarged by Professor Gorgas. 1028 Illustrations. Cloth, 7.00; Leather, 8.00

Richardson's Mechanical Dentistry. Fifth Edition. 569 Illustrations. 8vo. Cloth, 4.50; Leather, 5.50

Sewill. Dental Surgery. 200 Illustrations. 3d Ed. Clo., 3.00

Taft's Operative Dentistry. Dental Students and Practitioners. Fourth Edition. 100 Illustrations. Cloth, 4.25; Leather, 5.00

Talbot. Irregularities of the Teeth, and their Treatment. Illustrated. 8vo. Second Edition. Cloth, 3.00

Tomes' Dental Anatomy. Third Ed. 191 Illus. Cloth, 4.00

Tomes' Dental Surgery. 3d Edition. 292 Illus. Cloth, 5.00

Warren. Compend of Dental Pathology and Dental Medicine. Illustrated. Cloth, 1.00; Interleaved, 1.25

DICTIONARIES.

Gould's New Medical Dictionary. Containing the Definition and Pronunciation of all words in Medicine, with many useful Tables etc. ½ Dark Leather, 3.25; ½ Mor., Thumb Index, 4.25

Gould's Pocket Dictionary. 12,000 Medical Words Pronounced and Defined. Containing many Tables and an Elaborate Dose List. Thin 64mo. *Just Ready.* Leather, 1.25

Harris' Dictionary of Dentistry. Fifth Edition. Completely revised by Prof. Gorgas. Cloth, 5.00; Leather, 6.00

Cleaveland's Pronouncing Pocket Medical Lexicon. Small pocket size. Cloth, red edges .75; pocket-book style, 1.00

Longley's Pocket Dictionary. The Student's Medical Lexicon, giving Definition and Pronunciation, with an Appendix giving Abbreviations used in Prescriptions, Metric Scale of Doses, etc. 24mo. Cloth, 1.00; pocket-book style, 1.25

EYE.

Hartridge on Refraction. 5th Edition. Illus. Cloth, 2.00

Swanzy. Diseases of the Eye and their Treatment. 176 Illustrations. Fourth Edition. Cloth, 3.00; Leather, 3.50

Fox and Gould. Compend of Diseases of the Eye and Refraction. 2d Ed. Enlarged. 71 Illus. 39 Formulæ. Cloth, 1.00; Interleaved for Notes, 1.25

☞ *See pages 2 to 5 for list of Students' Manuals.*

ELECTRICITY.

Bigelow. Plain Talks on Medical Electricity. Cloth, 1.00

Mason's Compend of Medical Electricity. Cloth, 1.00

Steavenson and Jones. Medical Electricity. A Practical Handbook. Just Ready. Illustrated. 12mo. Cloth, 2.50

HYGIENE.

Coplin and Bevan. Practical Hygiene. By W. M. L. Coplin, Adjunct Professor of Hygiene, Jefferson Medical College, Philadelphia, and Dr. D. Bevan. Illustrated. *In Press.*

Parkes' (Ed. A.) Practical Hygiene. Seventh Edition, enlarged. Illustrated. 8vo. Cloth, 4.50

Parkes' (L. C.) Manual of Hygiene and Public Health. Second Edition. 12mo. Cloth, 2.50

Wilson's Handbook of Hygiene and Sanitary Science. Seventh Edition. Revised and Illustrated. Cloth, 3.25

MATERIA MEDICA AND THERAPEUTICS.

Potter's Compend of Materia Medica, Therapeutics, and Prescription Writing. Fifth Edition, revised and improved. *See page 15.* Cloth, 1.00; Interleaved for Notes, 1.25

Davis. Essentials of Materia Medica and Prescription Writing. By J. Aubrey Davis, M.D., Demonstrator of Obstetrics and Quiz-Master on Materia Medica, University of Pennsylvania. 12mo. Interleaved. *Net*, 1.50

Biddle's Materia Medica. Eleventh Edition. By the late John B. Biddle, M.D. Revised by Clement Biddle, M.D., 8vo, illustrated. Cloth, 4.25; Leather, 5.00

Potter. Handbook of Materia Medica, Pharmacy, and Therapeutics. Including Action of Medicines, Special Therapeutics, Pharmacology, etc. By Saml. O. L. Potter, M.D., M.R.C.P. (Lond.), Professor of the Practice of Medicine in Cooper Medical College, San Francisco. Third Revised and Enlarged Edition. 8vo. Cloth, 4.00; Leather, 5.00

White and Wilcox. Materia Medica, Pharmacy, Pharmacology, and Therapeutics. A Handbook for Students. By Wm. Hale White, M.D., F.R.C.P., etc., Physician to and Lecturer on Materia Medica, Guy's Hospital. Revised by Reynold W. Wilcox, M.D., Professor of Clinical Medicine at the New York Post Graduate Medical School, Assistant Physician Bellevue Hospital, etc. American Edition. Clo., 3.00; Lea., 3.50

☞ *See pages 14 and 15 for list of ? Quiz-Compends ?*

MEDICAL JURISPRUDENCE.

Reese. A Text-book of Medical Jurisprudence and Toxicology. By John J. Reese, M.D., Professor of Medical Jurisprudence and Toxicology in the Medical Department of the University of Pennsylvania; Physician to St. Joseph's Hospital. Third Edition. Cloth, 3.00; Leather, 3.50

NERVOUS DISEASES.

Gowers. Manual of Diseases of the Nervous System. A Complete Text-book. By William R. Gowers, M.D., Prof. Clinical Medicine, University College, London. Physician to National Hospital for the Paralyzed and Epileptic. Second Edition. Revised, Enlarged, and in many parts Rewritten. With many new Illustrations. Octavo.

VOL. I. **Diseases of the Nerves and Spinal Cord.** 616 pages. Cloth, 3.50

VOL. II. **Diseases of the Brain and Cranial Nerves. General and Functional Diseases.** *Nearly Ready.*

Ormerod. Diseases of Nervous System, Student's Guide to. By J. A. Ormerod, M.D., Oxon., F.R.C.P. (London), Member Pathological, Clinical, Ophthalmological, and Neurological Societies, Physician to National Hospital for Paralyzed and Epileptic and to City of London Hospital for Diseases of the Chest, Demonstrator of Morbid Anatomy, St. Bartholomew's Hospital, etc. With 75 Wood Engravings. Cloth, 2.00

OBSTETRICS AND GYNÆCOLOGY.

Davis. A Manual of Obstetrics. By Edw. P. Davis, Demonstrator of Obstetrics, Jefferson Medical College, Philadelphia. Colored Plates, and 130 other Illustrations. 12mo. Cloth, 2.00

Byford. Diseases of Women. The Practice of Medicine and Surgery, as applied to the Diseases and Accidents Incident to Women. By W. H. Byford, A.M., M.D., Professor of Gynæcology in Rush Medical College and of Obstetrics in the Woman's Medical College, etc., and Henry T. Byford, M.D., Surgeon to the Woman's Hospital of Chicago. Fourth Edition. Revised and Enlarged. 306 Illustrations, over 100 of which are original. Octavo. 832 pages. Cloth, 5.00; Leather, 6.00

Lewers' Diseases of Women. A Practical Text-book. 139 Illustrations. Second Edition. Cloth, 2.50

Parvin's Winckel's Diseases of Women. Second Edition. Including a Section on Diseases of the Bladder and Urethra. 150 Illus. Revised. *See page 3.* Cloth, 3.00; Leather, 3.50

Morris. Compend of Gynæcology. Illustrated. Cloth, 1.00

Winckel's Obstetrics. A Text-book on Midwifery, including the Diseases of Childbed. By Dr. F. Winckel, Professor of Gynæcology, and Director of the Royal University Clinic for Women, in Munich. Authorized Translation, by J. Clifton Edgar, M.D., Lecturer on Obstetrics, University Medical College, New York, with nearly 200 handsome Illustrations, the majority of which are original. 8vo. Cloth, 6.00; Leather, 7.00

☞ *See pages 2 to 5 for list of New Manuals.*

Obstetrics and Gynæcology:—Continued.

Landis' Compend of Obstetrics. Illustrated. 4th Edition, Enlarged. Cloth, 1.00; Interleaved for Notes, 1.25

Galabin's Midwifery. By A. Lewis Galabin, M.D., F.R.C.P. 227 Illustrations. *See page 3.* Cloth, 3.00; Leather, 3.50

PATHOLOGY, HISTOLOGY, ETC.

Wethered. Medical Microscopy. By Frank J. Wethered, M.D., M.R.C.P. 98 Illustrations. Cloth, 2.50

Bowlby. Surgical Pathology and Morbid Anatomy, for Students. 135 Illustrations. 12mo. Cloth, 2.00

Gilliam's Essentials of Pathology. A Handbook for Students. 47 Illustrations. 12mo. Cloth, 2.00

Virchow's Post-Mortem Examinations. 3d Ed. Cloth, 1.00

PHYSICAL DIAGNOSIS.

Fenwick. Student's Guide to Physical Diagnosis. 7th Edition. 117 Illustrations. 12mo. Cloth, 2.25

Tyson's Student's Handbook of Physical Diagnosis. Illustrated. 12mo. Cloth, 1.25

PHYSIOLOGY.

Yeo's Physiology. Fifth Edition. The most Popular Students' Book. By Gerald F. Yeo, M.D., F.R.C.S., Professor of Physiology in King's College, London. Small Octavo. 758 pages. 321 carefully printed Illustrations. With a Full Glossary and Index. *See page 3.* Cloth, 3.00; Leather, 3.50

Brubaker's Compend of Physiology. Illustrated. Sixth Edition. Cloth, 1.00; Interleaved for Notes, 1.25

Kirke's Physiology. New 13th Ed. Thoroughly Revised and Enlarged. 502 Illustrations, some of which are printed in colors. Cloth, 4.00; Leather, 5.00

Landois' Human Physiology. Including Histology and Microscopical Anatomy, and with special reference to Practical Medicine. Fourth Edition. Translated and Edited by Prof. Stirling. 845 Illustrations. Cloth, 7.00; Leather, 8.00

"With this Text-book at his command, no student could fail in his examination."—*Lancet.*

Sanderson's Physiological Laboratory. Being Practical Exercises for the Student. 350 Illustrations. 8vo. Cloth, 5.00

PRACTICE.

Taylor. Practice of Medicine. A Manual. By Frederick Taylor, M.D., Physician to, and Lecturer on Medicine at, Guy's Hospital, London; Physician to Evelina Hospital for Sick Children, and Examiner in Materia Medica and Pharmaceutical Chemistry, University of London. Cloth, 2.00; Leather, 2.50

☞ *See pages 14 and 15 for list of "Quiz-Compends"*

Practice:—Continued.

Roberts' Practice. New Revised Edition. A Handbook of the Theory and Practice of Medicine. By Frederick T. Roberts, M.D., M.R.C.P., Professor of Clinical Medicine and Therapeutics in University College Hospital, London. Seventh Edition. Octavo. Cloth, 5.50; Sheep, 6.50

Hughes. Compend of the Practice of Medicine. 4th Edition. Two parts, each, Cloth, 1.00; Interleaved for Notes, 1.25

PART I.—Continued, Eruptive and Periodical Fevers, Diseases of the Stomach, Intestines, Peritoneum, Biliary Passages, Liver, Kidneys, etc., and General Diseases, etc.

PART II.—Diseases of the Respiratory System, Circulatory System, and Nervous System; Diseases of the Blood, etc.

Physicians' Edition. Fourth Edition. Including a Section on Skin Diseases. With Index. 1 vol. Full Morocco, Gilt, 2.50

From John A. Robinson, M.D., Assistant to Chair of Clinical Medicine, now Lecturer on Materia Medica, Rush Medical College, Chicago.

"Meets with my hearty approbation as a substitute for the ordinary note books almost universally used by medical students. It is concise, accurate, well arranged, and lucid, . . . just the thing for students to use while studying physical diagnosis and the more practical departments of medicine."

PRESCRIPTION BOOKS.

Wythe's Dose and Symptom Book. Containing the Doses and Uses of all the principal Articles of the Materia Medica, etc. Seventeenth Edition. Completely Revised and Rewritten. *Just Ready.* 32mo. Cloth, 1.00; Pocket-book style, 1.25

Pereira's Physician's Prescription Book. Containing Lists of Terms, Phrases, Contractions, and Abbreviations used in Prescriptions, Explanatory Notes, Grammatical Construction of Prescriptions, etc., etc. By Professor Jonathan Pereira, M.D. Sixteenth Edition. 32mo. Cloth, 1.00; Pocket-book style, 1.25

PHARMACY.

Stewart's Compend of Pharmacy. Based upon Remington's Text-book of Pharmacy. Third Edition, Revised. With new Tables, Index, Etc. Cloth, 1.00; Interleaved for Notes, 1.25

Robinson. Latin Grammar of Pharmacy and Medicine. By H. D. Robinson, PH.D., Professor of Latin Language and Literature, University of Kansas, Lawrence. With an Introduction by L. E. Sayre, PH.G., Professor of Pharmacy in, and Dean of, the Dept. of Pharmacy, University of Kansas. 12mo. Cloth, 2.00

SKIN DISEASES.

Anderson, (McCall) Skin Diseases. A complete Text-book, with Colored Plates and numerous Wood Engravings. 8vo. Cloth, 4.50; Leather, 5.50

Van Harlingen on Skin Diseases. A Handbook of the Diseases of the Skin, their Diagnosis and Treatment (arranged alphabetically). By Arthur Van Harlingen, M.D., Clinical Lecturer on Dermatology, Jefferson Medical College; Prof. of Diseases of the Skin in the Philadelphia Polyclinic. 2d Edition. Enlarged. With colored and other plates and illustrations. 12mo. Cloth, 2.50

☞ *See pages 2 to 5 for list of New Manuals.*

SURGERY AND BANDAGING.

Moullin's Surgery. 500 Illustrations (some colored), 200 of which are original. 2d Ed. Cloth, net 7.00; Leather, net 8.00

Jacobson. Operations in Surgery. A Systematic Handbook for Physicians, Students, and Hospital Surgeons. By W. H. A. Jacobson, B.A. Oxon., F.R.C.S. Eng.; Ass't Surgeon Guy's Hospital; Surgeon at Royal Hospital for Children and Women, etc. 199 Illustrations. 1006 pages. 8vo. Cloth. 5.00; Leather, 6.00

Heath's Minor Surgery, and Bandaging. Ninth Edition. 142 Illustrations. 60 Formulæ and Diet Lists. Cloth, 2.00

Horwitz's Compend of Surgery, Minor Surgery and Bandaging, Amputations, Fractures, Dislocations, Surgical Diseases, and the Latest Antiseptic Rules, etc., with Differential Diagnosis and Treatment. By ORVILLE HORWITZ, B.S., M.D., Demonstrator of Surgery, Jefferson Medical College. 4th edition. Enlarged and Rearranged. 136 Illustrations and 84 Formulæ. 12mo. Cloth, 1.00; Interleaved for the addition of Notes, 1.25

*** The new Section on Bandaging and Surgical Dressings consists of 32 Pages and 41 Illustrations. Every Bandage of any importance is figured. This, with the Section on Ligation of Arteries, forms an ample Text-book for the Surgical Laboratory.

Walsham. Manual of Practical Surgery. Third Edition. By WM. J. WALSHAM, M.D., F.R C.S., Asst. Surg. to, and Dem. of Practical Surg. in, St. Bartholomew's Hospital; Surgeon to Metropolitan Free Hospital, London. With 318 Engravings. *See page 2.* Cloth, 3.00; Leather, 3.50

URINE, URINARY ORGANS, ETC.

Holland. The Urine, and Common Poisons and The Milk. Chemical and Microscopical, for Laboratory Use. Illustrated. Fourth Edition. 12mo. Interleaved. Cloth, 1.00

Ralfe. Kidney Diseases and Urinary Derangements. 42 Illustrations. 12mo. 572 pages. Cloth, 2.75

Marshall and Smith. On the Urine. The Chemical Analysis of the Urine. By John Marshall, M.D., Chemical Laboratory, Univ. of Penna; and Prof. E. F. Smith, PH.D. Col. Plates. Cloth, 1.00

Memminger. Diagnosis by the Urine. Illustrated. Cloth, 1.00

Tyson. On the Urine. A Practical Guide to the Examination of Urine. With Colored Plates and Wood Engravings. 7th Ed. Enlarged. 12mo. Cloth, 1.50

Van Nüys, Urine Analysis. Illus. Cloth, 2.00

VENEREAL DISEASES.

Hill and Cooper. Student's Manual of Venereal Diseases, with Formulæ. Fourth Edition. 12mo. Cloth, 1.00

☞ *See pages 14 and 15 for list of ? Quiz-Compends ?*

?QUIZ-COMPENDS?

The Best Compends for Students' Use in the Quiz Class, and when Preparing for Examinations.

Compiled in accordance with the latest teachings of prominent Lecturers and the most popular Text-books.

They form a most complete, practical, and exhaustive set of manuals, containing information nowhere else collected in such a condensed, practical shape. Thoroughly up to the times in every respect, containing many new prescriptions and formulæ, and over two hundred and fifty illustrations, many of which have been drawn and engraved specially for this series. The authors have had large experience as quiz-masters and attachés of colleges, with exceptional opportunities for noting the most recent advances and methods.

Cloth, each $1.00. Interleaved for Notes, $1.25.

No. 1. HUMAN ANATOMY, "Based upon Gray." Fifth Enlarged Edition, including Visceral Anatomy, formerly published separately. 16 Lithograph Plates, New Tables, and 117 other Illustrations. By SAMUEL O. L. POTTER, M.A., M.D., M.R.C.P. (Lond.), late A. A. Surgeon U. S. Army, Professor of Practice, Cooper Medical College, San Francisco.

Nos. 2 and 3. PRACTICE OF MEDICINE. Fourth Edition. By DANIEL E. HUGHES, M.D., Demonstrator of Clinical Medicine in Jefferson Medical College, Philadelphia. In two parts.

PART I.—Continued, Eruptive, and Periodical Fevers, Diseases of the Stomach, Intestines, Peritoneum, Biliary Passages, Liver, Kidneys, etc. (including Tests for Urine), General Diseases, etc.

PART II.—Diseases of the Respiratory System (including Physical Diagnosis), Circulatory System, and Nervous System; Diseases of the Blood, etc.

*** These little books can be regarded as a full set of notes upon the Practice of Medicine, containing the Synonyms, Definitions, Causes, Symptoms, Prognosis, Diagnosis, Treatment, etc., of each disease, and including a number of prescriptions hitherto unpublished.

No. 4. PHYSIOLOGY, including Embryology. Sixth Edition. By ALBERT P. BRUBAKER, M.D., Prof. of Physiology, Penn'a College of Dental Surgery; Demonstrator of Physiology in Jefferson Medical College, Philadelphia. Revised, Enlarged, with new Illustrations.

No. 5. OBSTETRICS. Illustrated. Fourth Edition. By HENRY G. LANDIS, M.D., Prof. of Obstetrics and Diseases of Women in Starling Medical College, Columbus, O. Revised Edition. New Illustrations.